MANAGEMENT HANDBOOK

To Aid Emergency Expansion of

Dehydration Facilities for Vegetables and Fruits

VOLUME II

CARROT SUPPLEMENT

A Phase II Preparedness Study

Prepared at the Request of
Office of the Quartermaster General
Department of the Army
Washington, D. C.

By

Western Regional Research Laboratory
Bureau of Agricultural and Industrial Chemistry
Agricultural Research Administration
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TABLE OF CONTENTS

Tables

Illustrative Material

CHAPTER I

BASIC ASSUMPTIONS

Foreword

The planning of a dehydration plant meeting national emergency needs should take full cognizance of the information and suggestions given in Volume I of this Handbook. This set of plans for a CARROT DEHYDRATION PLANT is based upon the principles set forth in that portion of the Handbook.

Product Desired

The plant covered in this Supplement of the Handbook is designed to produce dehydrated carrot dice (Type I) in accordance with the Military Specification "Carrots, Dehydrated" (MIL-C-839) dated 28 July 1949.

Bases for Operations, Facilities, and Cost Estimates

A. Location of Plant

Inasmuch as most of the carrot dehydration during World War II and subsequently for commercial markets has been done in California, these estimates are based on a plant located in California. The general plan, design, and operations are applicable, however, to plants located in other areas.

B. Operating Basis

Design and cost estimates are based upon an operation of three 8-hour shifts per day, six days per week, and 250 operating days per year. A longer period of operation might be possible, however, under very favorable circumstances of raw material supply. All labor costs are based on regular union rates for 1951 in central California. The labor rates used in this set of plans are as follows:

Class Labor	Hourly Rate
1	$1.90
2	1.73
3	1.55
4	1.42
5	1.34
6	1.18

C. Raw Commodity Used

It has been assumed that entire production will be done with field run Imperator or Red Cored Chantenay carrots. If other varieties are used, the shrinkage ratios and production costs may be different than assumed in this Handbook.

It is assumed that carrots will be obtained directly from growers under contract. Only the amount of carrots necessary to insure continuous and efficient operation of the plant will be stored.

Provision has been made in the cost estimates for raw commodity prices ranging from $10 per ton to $40 per ton delivered in sacks to the plant.

D. Plant Capacity and Yields

This plant has been designed to process 100 tons of raw carrots per day. It is assumed that the preparation line will operate 20 hours per day and have a nominal capacity of 5 tons of raw carrots per hour. The dehydration tunnels and bins will operate 24 hours per day to dry the material prepared in 20 hours. The packaging line will operate 20 hours per day.

The over-all shrinkage ratio for this plant is assumed to be 11:1. General experience in this field indicates shrinkage ratios may range from 9:1 to 15:1. On the basis of an 11:1 over-all shrinkage ratio, 100 pounds of raw carrots entering the processing line yield 9.1 pounds of finished dried product.

In addition, it is assumed that 0.45 pounds of "fines" and 0.45 pounds of "defects" will be produced; if no use is found for these materials, they will be hauled away with the plant wastes.

E. Storage Space

Storage space in the plant building is provided for holding a one- to two-day supply of raw commodity. Space also has been provided for holding up to a 30-day production of packaged and cased dehydrated carrot dice plus a 10-day supply of empty cans and cases, or any desired combination of these items.

F. Waste Disposal

It is assumed that the solid wastes will be hauled away from the plant, for stock feed, at no cost to the plant.

CHAPTER II

SUPPLY OF RAW CARROTS

Characteristics Desired in Carrots to be Dehydrated

Military specifications (Carrots, Dehydrated, MIL-C-839, dated 28 July 1949) require that carrots used for dehydration shall be clean, sound, mature, of good cooking quality, and of good typical orange color. Red Cored Chantenay, Imperator, or similar varieties, are required. The specifications also provide that the raw material shall be of U. S. No. 1 Grade (except for size). This refers to Standards for carrots established by the U. S. Department of Agriculture to facilitate transactions between growers and purchasers. This grade consists of carrots which are of the same general type, and which are not soft, flabby, or shriveled. The carrot must have a characteristic orange or orange-red color throughout. The carrots should not be forked, crooked, rough, ridged, or covered with secondary rootlets. The flesh of the carrot must not be tough and fibrous. The carrots must be free from soft rot, dirt, weeds, or other foreign matter. The carrots should be free from any injury or defect which materially affects quality, such as that which is caused by growth cracks, sunburn, green cores, pithy cores, watercore, internal discoloration, oil spray, freezing, dry rot or other disease, insects, or by mechanical or other means. Small tolerances are allowed for carrots which fail to meet these requirements.

Color is one of the most important special characteristics desired in carrots to be used for dehydration. The deep-orange or orange-red color should prevail throughout the root, even into the interior of the core. In addition to having a more attractive appearance on the plate, deep and uniformly colored carrots have a greater carotene content than poorly colored ones. For dehydration purposes the roots should be mature, but not so mature as to be woody. The carrot commonly used for dehydration is larger, has a larger proportion of carotene, and usually has more solids content than the relatively immature fresh-market carrot.

Suitable Dehydration Varieties and Commercial Production Data

A. Varieties

Two varieties of carrots, Imperator and Red Cored Chantenay, are the most widely grown in the United States, and both are satisfactory for dehydration.

The Imperator is a relatively new variety -- first introduced in 1928. It has become the principal carrot grown in California, Texas, and Arizona for fresh shipment to all large markets; it has an attractive appearance and is easy to pack and ship as a fresh-market carrot. It is grown at all seasons of the year and requires from 80 to 120 days to reach fresh-market size (1 to 1-1/2 inches in diameter and 6 to 7 inches long). It has a deep-orange flesh and slightly lighter core. Imperators with a 180-day growing season were successfully used on a large scale for dehydration during World War II.

The Red Cored Chantenay also is a relatively new variety, introduced in 1929. It is now the most widely used general purpose variety and is known and grown throughout the U. S. It is the most popular canning carrot in Wisconsin, New York, and Oregon. The Chantenay is adaptable to a greater range of soil types than is the Imperator. The roots have a greater diameter and are shorter and more blunt-pointed than the Imperator. Due to its tendency to protrude above the ground as it matures, it is subject to sunburn. It was widely grown for dehydration during World War II.

The Red Cored Chantenay has deep-orange flesh and core, and the dehydrated product is definitely deeper orange and contains more carotene than that made from Imperators. The Chantenay has a little more solids content than the Imperator and has good color even when immature.

During World War II, experienced dehydrators who had used quantities of both leading varieties tended to favor the Imperator for several reasons: (a) the Imperator is most readily available in large quantities; (b) the mechanical handling quality of Imperators is superior; (c) the individual carrots are less likely to be sunburned or have green crowns and cores; (d) in growing toward maturity, Imperators are less likely to acquire an undesirable woody texture; and (e) the flavor of Imperators is better than other varieties. Since World War II, most of the dehydrated carrots produced in California have been of the Imperator variety.

The principal characteristics of the major varieties of carrots grown commercially in the United States are summarized in Table I.

B. Important Producing Areas

Various production data for the principal carrot-producing States are shown in Table II and Table III.

The principal carrot-producing States are California, Texas, New York, and Arizona. California production is nearly four times that of any other State. In World War II about 95% of the U. S. production of dehydrated carrots came from California. Table IV shows the principal producing areas in California. The Salinas Valley of Monterey County and the Imperial Valley are the chief areas of carrot production. The west side of the San Joaquin Valley is an area of experienced carrot growers, and although present production is not large, it is capable of great expansion if desired.

Texas, New York, and Arizona carrot production is sufficient to supply raw commodity for dehydration purposes. The length of period that carrots are available in any area must be considered; Northern States generally have short harvest seasons.

Procurement Problems

The procurement of sufficient supplies of carrots for dehydration during a national emergency period should not be a serious problem. Dehydrated carrot supplies were ample during World War II, so much so that production of carrots for dehydration was curtailed during the later years of the war. Large-scale growers in California should be able to produce all the carrots that are likely to be needed by the military forces.

A. Supply of Seed

The major portion of the carrot seed produced in the country is grown in the Central Valley of California. The Imperator seed is grown almost exclusively in Cali-

fornia. Carrots grown for seed production are generally planted in July, the roots are dug and rogued in December and immediately replanted in the fields, and the seed is harvested the following August.

California dehydrators report that about three pounds of seed per acre are planted and that a good yield of dehydration-size carrots is about 20 tons per acre. This yield is nearly twice the average State yield for fresh market carrots. On the basis of these reports, about 4,000 pounds of seed, planted on 1,300 acres of land, and producing 25,000 tons of carrots, would be required for a 100-ton a day dehydration plant operating 250 days a year.

There should be no serious difficulty in obtaining an adequate supply of seed if dehydrators use either of the two leading carrot varieties. In 1951, a relatively poor year for seed production, 278,000 pounds of Imperator seed and 204,000 pounds of Red Cored Chantenay seed were produced. Seed of these two leading varieties accounted for over 50% of total carrot seed production. If supplies of seed must be increased above normal, the requirements must be made known before August 1st to permit planting for seed production at the proper time. Carrot seed can be planted immediately after being harvested and cleaned.

Table V gives the production of carrot seed according to principal varieties during the period 1948-1951.

B. Soil, Fertilizer, and Other Cultural Requirements

Carrots grow well on many soil types, although well-drained sandy loam is preferred. Excellent yields are produced on the heavier soils of the Imperial Valley and the dark-colored silty loams of the Salinas Valley of California. Carrots for fresh market are often grown on the lighter soils, resulting in an early and rapid growth, smooth roots, and the flavorful and succulent carrot desired. Carrots for dehydration may be grown on the heavier type soils which offer greater fertility and water-holding capacity and greater yields.

In preparation for planting, the soil should be thoroughly worked and properly graded for good irrigation. Large amounts of commercial fertilizer should be applied before the beds are formed. Manures or green manures also are beneficial in carrot growing. Two rows of seed about 12 inches apart are planted on raised beds four to six inches high and 18 to 20 inches wide. Large amounts of irrigation water are used, from a minimum of 18 inches in the Salinas Valley of California, to as much as 36 inches in the desert valleys (such as Imperial Valley). As carrot seed is slow to germinate and the young plants grow slowly in their early stages, the weed problem is especially troublesome. Hoeing is extremely expensive, and early elimination of weeds with stove-oils or other sprays is an established practice.

Deficiency of a nutrient element in the soil may cause some adverse changes in color of the carrots. Excessive heat or cold, or poorly drained soils, will cause the carrots to be light-colored.

Carrots may be damaged by nematodes and wireworms. It is necessary that infested soil areas be carefully and thoroughly treated by applying fumigants, or other toxic materials, to the soil. The cost of such soil fumigation is reasonable.

C. Harvesting and Transporting of Carrots

In California, carrots for dehydration may be planted so as to provide a continuous harvest of prime maturity throughout the year. It is possible to schedule plantings so that a regular supply of carrots can be made available for a dehydration plant. Current harvest seasons and localities available to California processors are

shown in the following table:

Locality	Season
Yuma (Arizona) Imperial Valley	January - May
Kern County - West Side San Joaquin Valley Bakersfield Area	January - June
Oxnard	March - June
Modesto and Delta Area	June - August
Salinas Area	April - January

Carrots are harvested for fresh market when the majority of the roots reach a diameter of three-quarters to one-and-one-quarter inches. For dehydration, however, roots over two inches in diameter and weighing about six ounces each are more desirable. To get the desired size and maximum carotene, carrots should be harvested about 180 days after planting, except for above-average growing conditions. It has been found undesirable to dig carrots for dehydration within two weeks after irrigation or rain, because of the temporary loss of the deep-orange color. Color in carrots, definitely related to carotene content, is markedly influenced by the age of the roots; the color usually increases during approximately the first 100 days of growth. Carrots should be harvested fully mature for maximum carotene content.

Reports of average yields of carrots, such as shown in Table III, are heavily weighted by the yields of fresh-market carrots. For example, the reported average yield of California carrots is about 10 tons per acre, whereas the yield in this State for carrots used for dehydration averages approximately 20 tons per acres.

Table VI and Figure 1 give planting and harvesting seasons for the principal carrot producing states.

D. Storing Raw Materials

Continuous year-around harvest of carrots in California is possible so there is no need for the storing of carrots to provide material for year-around operation of a dehydrator. The carrot dehydrator will ordinarily buy his raw material direct from the farmer under contract and not through brokers, dealers, or storage houses.

E. Competing Outlets for Carrots for Dehydration

The chief outlet competing with dehydrators for carrots is the fresh market. Less than 20% of the carrots shipped to distant markets are "topped". A smaller competing outlet for carrots is the canneries. In New York, Wisconsin, and Oregon an important part of the production is finally marketed as canned carrots.

The principal growers in California, Arizona, and Texas plan their crops to satisfy the fresh market demand for carrots. The weekly shipments of fresh-market carrots from these States averaged about 500 cars per week during the period from December 1949 to June 1950. These go to the city markets throughout the United States. In the case of a national emergency an immediate supply for dehydration might be obtained by converting part of the fresh-market carrot supply.

F. Competition with Other Crops for Acreage

Carrots compete with lettuce and onions for the use of land in the Salinas Valley and Imperial Valley of California. In the winter crop areas, carrots are also in competition with many kinds of vegetables grown for the high-priced, very early market. And in the East and Midwest where carrots are grown on the limited areas of productive muck lands, they compete with such vegetables as onions and celery.

Carrots are commonly grown in rotation with other vegetables and with legumes. The rotation cycle may consist of growing carrots (or alternating with other vegetables) for three or four consecutive years, followed by three years of growing legumes such as alfalfa.

There are economies in growing carrots for the dehydrators. Less harvesting labor is used when the tops are snapped off for the dehydration outlet than is needed for sorting and tying the crop for the fresh market. In addition to a lower harvesting cost and greater yield, the grower under contract to a dehydrator will have a less critical and more flexible harvesting period. Also, such a grower does not have to be subject to the vacillations of a changing market price, but harvests the crop at a regular agreed-upon rate and receives an agreed-upon set price.

G. Considerations in Obtaining Carrots of Proper Grade

The dehydrator of carrots will ordinarily buy from a selected grower under contract. The contract should emphasize quality and specify variety, size, and maturity standards.

Inasmuch as standards of maturity for dehydration purposes will allow the carrots to remain in the ground far longer than if grown for the fresh market, the carrots will become much larger than average market size, and yields will be two or three times as great. On the other hand, the dehydrator will not expect to pay the farmer what he would receive for fresh-market carrots. The 1940-1949 ten-year average price received by farmers in California was $65 and the U. S. average was $52 per ton. Records furnished by a large California commercial dehydrator, however, indicate an average price to farmers producing under contract of approximately $18 per ton during the 1942-1951 ten-year period. The contract price of $20 per ton in both 1950 and 1951 would indicate that growers have found it advantageous to grow carrots at this price even with the increased costs of labor, fertilizer, and equipment.

A well-qualified and energetic field man employed by the dehydrator can assist growers in producing an abundance of high quality carrots by timely advice as to fertilizer needs, weed and insect control, irrigation practices, and proper maturity.

A final consideration in obtaining carrots of desired quality is the continuous employment of a Federal and/or State inspector to inspect for grade all carrots coming to the processing plant.

Additional Sources of Information

Babb, M. F., Kraus, J. E., and Magruder, R. Synonymy of Orange-Fleshed Varieties of Carrots. Washington, D. C., 1940. (U. S. Dept. of Agric. Miscellaneous Publication 361) 100 p.

Beattie, J. H., and others. Production of Carrots. Rev. ed. Washington, D. C., 1944. (U. S. Dept. of Agric. Leaflet 125) 4 p.

Caldwell, J. S., and others. "Comparative Suitability for Dehydration in Thirty Varieties and Strains of Orange-Fleshed Carrots". In: FRUIT PRODUCTS JOURNAL 24 (1):7-16, 24, Sept. 1944.

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Dunn, Lt. Col. C. G. "Remarks Concerning the Army's Dehydrated Foods Program". In: Maryland Dehydration Conference, College Park, Md., May 12-14, 1943. Proceedings pp. 18-25.

Federal-State Market News Service, Brawley, Calif. Marketing Imperial Valley of California Carrots, 1944, 1950. Brawley, 1945, 1951.

Magruder, R., and others. Descriptions of Types of Principal American Varieties of Orange-Fleshed Carrots. Washington, D. C., 1940. (U. S. Dept. of Agric. Miscellaneous Publication 361) 48 p.

Whitaker, T. S., and others. Carrot Production in the West and Southwest. Washington, D. C., 1946. (U. S. Dept. of Agric. Circular 750) 32 p.

TABLE I

Characteristics of Principal Orange-Colored Varieties of Carrots 1/

Variety Designation: Synonymns & Modifications	Shape	Typical Dimensions 2/ Diameter Inches	Length Inches	Weight 2/ Ounces	Special Characteristics
French Forcing Earliest Red Horn Earliest Short Horn Early Golden Ball	Round to oval	1.5 to 2	1.5 to 2	1.2 to 1.7	Strong resinous flavor, roots crack
Scarlet Horn Early Dutch Horn Early Scarlet Early Short Horn	Conic to cylindrical	1 to 2	3 to 4	1.7 to 2.8	Roots tend to crack and easily become woody
Nantes Coreless Early Half Long Nantes Half Long Coreless Nantes Amsterdam Forcing Touchon	Cylindrical	1 to 2	5 to 6	2.1 to 3.2	Exceeds all in culinary qualities, sweet, tender, crisp
Chantenay Coreless Chantenay Goldinhart Ribicore Red Cored Chantenay	Conic to truncate	1 to 2	4.5 to 5	3.5 to 6.2	Deep-orange flesh and core
Danvers Danvers Half Long Danvers Half Long Scarlet Hutchinson Tendersweet	Long conic	1 to 2	5 to 6	3.0 to 4.7	Light-colored flesh, yellow core
Imperator Lompoc California Bunching Morse Bunching Streamliner	Long with slight taper	1 to 1.5	6 to 7	2.3 to 3.5	Shape developed for bunching by crossing Nantes and Chantenay
Long Orange Long Red Long Red Surrey Long Scarlet	Very long conic	1.5 to 2	7 to 12	2.6 to 4.6	Its long roots are difficult to harvest
Oxheart Early Gem Early Guerande Norfolk Gem	Medium conic to heart-shaped	2 to 2.5	3 to 3.5	3.5 to 6	Strong flavor; roots crack

1/ Both the flesh and core of the varieties of carrots listed are orange colored
2/ For dehydration larger sizes than these are desired

Sources:
Babb, M.F., Kraus, J.E., and Magruder, R. Synonymy of Orange-Fleshed Varieties of Carrots. Washington,D.C.,1950. (U.S. Dept. of Agric. Circular 833)
Caldwell, J.S., and others. "Comparative Suitability for Dehydration in Thirty Varieties and Strains of Orange-Fleshed Carrots". In: FRUIT PRODUCTS JOURNAL 24(1):7-16,24, Sept.1944
Magruder, R., and others. Descriptions of Types of Principal American Varieties of Orange-Fleshed Carrots. Washington,D.C.,1940. (U.S. Dept. of Agric. Miscellaneous Publication 361)

TABLE II

Factors Pertaining to the Commercial Production for Principal Varieties of Carrots

Variety Name	Use	Soil Adaptability	Days to Maturity 1/ Spring, Summer	Days to Maturity 1/ Fall, Winter	Seed Production 1950 Pounds	Historical Notes
French Forcing	Forcing & home gardens 2/	Prepared soils of hot-beds or cold frames	60-75	85-100	3/	--
Scarlet Horn	Home garden	Shallow or hard soil	70-80	90-100	3/	Not grown extensively in U. S.
Nantes	Market garden 4/	Fine sand, sandy loam, and muck	70-80	90-100	209,100	--
Chantenay	Canning & storage	Suited to most soils	75-85	90-120	381,300	Red Cored Chantenay, introduced in 1929, has become the most used variety in U. S.
Danvers	Fresh market & storage	Deep, light soils	80-90	90-120	259,500	Formerly most popular variety, being replaced by Imperator
Imperator	Fresh market & shipment	Deep, well-drained, sandy loam	80-90	95-120	459,500	Introduced in 1928. Chief variety now used for dehydration
Long Orange	Market garden & stock feed	Deep, light soils	90-100	100-120	19,700	Most popular at one time (1865). Being replaced by Chantenay and Imperator
Oxheart	San Francisco market & stock feed	Shallow and heavy soils	75-90	90-110	3/	--

1/ From date of germination to prime fresh-market size when grown as a spring and summer crop and when grown as a fall crop in the Northern States or a winter crop in the Southern States and California. Note: For dehydration a longer growing season is expected

2/ French Forcing is generally being supplanted by the Nantes variety

3/ Included in production of 81,700 pounds of seed of all other varieties. Total production in 1950 was 1,410,800 pounds

4/ Nantes is too brittle in top and root for "bunching" and shipment for fresh market

Source:

Caldwell, J.S., and others. "Comparative Suitability for Dehydration in Thirty Varieties and Strains of Orange-Fleshed Carrots". In: FRUIT PRODUCTS JOURNAL 24(1):7-16,24, Sept.1944

Magruder, R., and others. Descriptions of Types of Principal American Varieties of Orange-Fleshed Carrots. Washington, D.C.,1940. (U.S. Dept. of Agric. Miscellaneous Publication 361)

U.S. Bur. of Agric. Econ. Acreage and Production of Vegetable Seeds, 1950-1951. Washington, D.C.,1951 (Apr.20)

TABLE III

Commercial Carrot Production, Acreage, Yield, and Price in Principal States

State and Crop	Ten-Year Average 1940 through 1949 Production Tons	Acreage Acres	Yield Tons/Acre	Price $/Ton	1950 Price $/Ton	1951 Price $/Ton
California	273,535	27,290				
Winter	91,800	9,840	9.3	66	64	76
Spring	70,350	6,550	10.7	58	64	100
Fall	111,375	10,900	10.2	67	76	116
Texas	73,450	16,540				
Winter	73,450	16,540	4.4	23	30	42
New York 1/	54,350	4,670				
Summer	14,225	1,350	10.5	49	30	62
Fall	40,125	3,320	12.1	32	24	34
Arizona	52,425	6,160				
Winter	19,500	2,800	7.0	79	94	88
Spring	32,925	3,360	9.8	70	60	80
Michigan 1/	25,750	1,780				
Fall	25,750	1,780	14.5	32	28	34
Other States 2/	135,475	16,420	8.3	--	--	--
U. S. Total 2/	614,975	72,860	8.4	52	54	76

1/ Carrots used for canning (1940-49 average) were handled by processors approximately as follows:

10,250 tons in Northwest (Wash.-Oregon)
9,525 tons in Wisconsin
6,625 tons in New York
1,950 tons in Michigan
1,200 tons in Maryland
1,125 tons in Utah
14,725 tons in other States

2/ Includes only states for which figures are issued as having a "commercial crop".

Source:

National Canners' Association. Canned Food Pack Statistics... Part I - Vegetables, 1944, 1946, 1950. Washington,D.C.,1945-51

U.S. Bur. of Agric. Economics. Commercial Truck Crops for Fresh Market. Annual Summary, 1951. Washington,D.C.,1951

TABLE IV

Carrot Acreage in Principal Producing Counties of California
(Highest and Lowest Averages for the Period 1941-1950)

County	Harvesting Season	Highest Average Acres	Highest Average Year	Lowest Average Acres	Lowest Average Year
Imperial	Winter	11,000	1950	8,000	1942
Monterey	Fall	7,660	1944	3,400	1941, 1942
Monterey	Spring	3,600	1948	1,500	1942
Los Angeles	Fall	3,300	1943	500	1950
Los Angeles	Spring	3,000	1943	200	1950
Santa Barbara	Fall	1,770	1946	950	1947
Santa Barbara	Spring	900	1943	200	1950
Fresno	Fall	1,100	1945	300	1941, 1949
Fresno	Spring	1,100	1944	200	1942

Source:
California Crop and Livestock Reporting Service, Vegetable Crops in California ...by Counties, 1941-1946; 1945-1950. Sacramento,1947-50.

TABLE V

Production of Carrot Seed by Varieties 1/
(1948 - 1951)

Variety	1948 (Lbs.)	1949 (Lbs.)	1950 (Lbs.)	1951 2/ (Lbs.)
Imperator 3/	252,800	357,200	459,500	277,900
Chantenay, Red Cored 3/	348,200	353,900	245,000	203,700
Chantenay (Other)	247,400	87,200	136,300	63,100
Danvers	117,300	107,300	259,500	175,200
Nantes	265,600	299,800	209,100	98,600
Long Orange	45,600	38,100	19,700	21,800
Other Varieties	75,600	138,600	81,700	34,000
Total	1,352,500	1,382,100	1,410,800	874,300

1/ Production by 130 commercial seed growers who usually have accounted for about 95 percent of the total commercial seed production in the United States
2/ Indicated by growers' intentions
3/ Used for dehydration in World War II

Source:
U.S. Bur. of Agric. Economics. Acreage and Production of Vegetable Seeds, 1948-49,1949-50,1950-51. Washington,D.C.,1950 (Jan.,May) -1951(Apr.)

TABLE VI

Usual Planting and Harvesting Periods for Carrots in Principal Producing States

State and Season	Planting	Harvesting			Growing District
		Begins	Most Active	Ends	
California					
Winter	Sept. 1 - Nov. 30	Dec. 1	Mar. - May	June 10	Imperial and other desert valleys
Spring	Nov. 1 - Feb. 28	May 15	June - July	July 30	Salinas, Oxnard, Firebaugh and Santa Maria
Fall	Feb. 1 - Aug. 31	Aug. 1	Oct. - Dec.	Jan. 31	Salinas, Santa Maria, Firebaugh, and Oxnard
Arizona					
Winter	Aug. 20- Oct. 31	Nov. 1	Dec. - Feb.	Feb. 28	Salt River Valley, Yuma
Spring	Dec. 15- Feb. 28	Mar. 1	Apr. - June	July 20	Salt River Valley
Texas					
Winter	Sept. 1- Jan. 15	Nov. 25	Jan. - May	June 30	Southern
New York					
Summer	Apr. 15- June 30	July 1	Aug. - Oct.	Nov. 30	Long Island, Orange and Erie Counties
Fall	June 1 - June 30	Sept.1	Sept.--Oct.	Nov. 30	Western
Michigan					
Fall	May 1 - June 15	July 1	Aug. - Sept.	Oct. 31	Southwestern and Southeastern

Source:

U.S. Bur. of Agric. Econ. Commercial Truck Crops for Fresh Market: Usual Planting and Harvesting Dates and Principal Producing Areas by Seasonal Groups and States. Washington,D.C.,1951 (May)

"Unloading a Tray of Carrot Dice After the Tunnel Drying Operation"

(Courtesy of WESTERN CANNER AND PACKER)

CHAPTER III

PLANT PROCEDURES AND FACILITIES

This section gives pertinent information concerning the operating procedures and the facilities required for a carrot dehydration plant. The information is coded and presented in accordance with the classification key given in Appendix D ("Operation Classification Code") of Volume I. The accompanying flow-sheet, drawings of equipment and facilities, and other illustrative material have been labeled in accordance with this same classification. (Note: This same classification key has been used in compiling the "Cost of Facilities" and "Total Production Costs", and thus affords a useful cross-reference system for identifying or discussing any phase of the operations and/or costs.)

The operational procedures and facilities needed for this proposed carrot dehydration plant are presented in accordance with the attached flow-sheet (Figure 2). A floor-plan (Figure 3) is given to show the space and arrangement required for the facilities.

100 — RAW MATERIALS

Many of the problems and methods of procuring a suitable supply of carrots for a dehydration plant have been discussed in "Supply of Raw Carrots" (Chapter II).

170 — Sack Expense

Customary practice has been to handle carrots in sacks from the field to the processing plant, although one plant operator believes that bulk handling of carrots is quite feasible if proper equipment is used. The proposed operation is based on the use of sacks. For use in the field, hauling, and storage at the plant, sufficient sacks have been provided to hold the amount of carrots needed for one week of plant operation. Life expectancy of sacks runs from 10 to 30 trips (between field and plant), and occasionally more, depending upon the exposure and the care with which the sacks are handled. Procurement of replacement sacks will be necessary during the operating seasons.

200 — MANUFACTURING OPERATIONS

210 — Raw Material Handling

211 — Weighing (at plant)

It is assumed that the truck-loads of carrots will be weighed at the plant.

212 — Unloading and storing at the plant

Palletized operations are proposed for handling raw carrots. It is desirable that carrots be dehydrated as soon as possible after harvesting to assure maximum quality and ease of preparation for drying. Under normal California weather conditions, the plant will have to shut down during some periods of the winter months for lack of raw material. Storing raw commodity for these infrequent periods does not seem justified in view of the undesirable changes which occur in carrots during storage. With good procurement practices, a plant should be able to realize 250 operating days per year on freshly harvested raw material.

220-230 — Preparing

The layout of the "preparation line" for the proposed carrot plant is shown in Figure 4.

221 — Washing

Two methods of washing may be used:

1) "Dry washing" followed by water washing

2) Water washing only

Present operators have indicated a strong preference for the use of dry washing and the proposed preparation line includes that method. Dirt, undersized carrots, and debris are eliminated by the dry washer, and the quantity of these materials can be readily checked if desired. (The price to be paid to the producer may be based on carrots free of surplus dirt and other debris.)

A thorough water wash to remove remaining dirt is necessary before the carrots are processed.

223 — Peeling

223.3 — Steam peeling
223.9 — Washing

Carrots may be readily peeled by steam or lye. One company that has used both steam and lye prefers steam peeling because of lower losses and elimination of troubles encountered in handling lye. The proposed plant is equipped for steam peeling. This operation is followed by a vigorous washing to remove loose peel still adhering to the carrots. Reported conditions for steam peeling range from 40 to 120 seconds at 70 lbs./sq. in. to 25 to 30 seconds at 100 lbs./sq. in. (Lye peeling requires three to five minutes in 5% solution at 210° F.) ~~to 215° F.)~~

224 — Trimming and inspecting

Average trimming labor requirements have been estimated to be 45 women for handling carrots of good quality at a rate of five tons per hour. Since there will be times when more trimmers are needed, such as when the carrots are small or of poor quality, space for additional trimmers is provided on the merry-go-round belts.

226 — Dicing

The proposed plant is designed for the production of half-dice (3/8" x 3/8" x 3/16"). By proper choice of knives for the cutters, full dice or strips (Type II) also may be cut. One extra dicer is provided in the plant layout to assure continuous dicing at the required rate.

227 — Blanching and sulfiting

After the dicing operation, the product may be washed (if desired) by sprays on the front end of the blancher belt. For the desired capacity, the blancher provided in this plant permits a maximum blanching time of six to seven minutes when the belt loading is four pounds per square foot. Adjustable belt speed is provided so that blanching conditions may be varied. Sulfite solution is sprayed on the product at the discharge end of the blancher. A stainless steel blancher belt is specified.

Wood tanks are provided for the sulfite make-up. Concentration and amount of sulfite solution required to obtain the proper sulfite content in the finished product (500 to 1000 p.p.m. of sulfur dioxide) are determined by trial. Sulfite solution concentrations should be in the range from 0.2% to 1.0%.

If the tunnel driers are gas-fired (as assumed for this plant), all the sulfite in the product is imparted by this spraying. If the driers are oil-fired an appreciable amount of sulfite may be picked up by the commodity from the combustion products of the oil. (For further discussion of sulfiting, see Chapter X of Volume I.)

240 — Drying

241 — Tunnel drying

241.1 — Tray loading

Tray loading is accomplished by means of two vibrating chutes which receive material from the blancher belt and which spread the commodity evenly onto trays. The trays are fed to a vari-drive drag chain conveyor located under the blancher, which moves the trays forward and underneath the vibrating chutes. The rate of tray movement is controlled so as to load the trays at a weight of 1.25 pounds per square foot in keeping with average commercial practice.

241.2 — Tray stacking

The loaded trays are then stacked on the trucks by means of a mechanical stacker. (Trays are stacked both mechanically and manually in industry.)

241.3 — Weighing

Prior to entering the drying tunnel, each loaded truck is weighed on scales built underneath a section of the track.

241.4 — Tunnel operating

Dehydrated carrots have been produced very successfully in both one- and two-stage driers (followed by bin drying). Because

of the greater simplicity in construction and operation, the proposed plant (for use in an emergency) is based on one-stage driers. One-stage, counter-current tunnel design features are shown in Figures 5 and 6. Eight one-stage tunnels are arranged in pairs with a single combustion chamber and air-blower for each pair. The following data are used as the basis for tunnel requirements:

1.	Direction of air-flow	Counter-current
2.	Air velocity between trays	800 ft./min.
3.	Volume of air per tunnel (Required capacity of a single blower supplying two tunnels is 40,000 c.f.m.)	20,000 c.f.m.
4.	Type of firing	Direct
5.	Method of firing	Overhead
6.	Type of fuel	Gas
7.	~~Incoming~~ Hot-end air temperature	160° F.
8.	Tray loading	1.25 lbs./sq. ft.
9.	Size of trays	3 ft. x 6 ft.
10.	Number of trays per truck	25
11.	Maximum number of trucks per single tunnel	12
12.	Moisture content of material entering tunnel	88%
13.	Moisture content of material leaving tunnel	8%
14.	Drying time	7 hrs.

241.5 - Tray unloading

The trays are removed from the trucks by hand and inverted over a hopper. The hopper is equipped with a revolving brush or scraper over which the inverted tray passes. The trays are then turned face up and manually reloaded on a truck.

241.7 — Tray washing

In industry, the frequency of tray washing varies from three or four times a season to every time the trays are unloaded. It is assumed in the proposed plant that the trays will be washed once a week by a special crew working on Sundays or other periods when the plant is not in operation. Tray washing can be conveniently done on the tray conveyor between the tray loader and stacker (Figure 4, codes 241.1 and 241.2). Banks of spray nozzles, both above and below the tray level on the conveyor, can be provided for use when the trays are to be washed.

248 — Bin drying

The proposed plant for diced carrots employs portable bins and bin-room equipment designed on the basis of the following data:

1) Air flow rate through bins - 100 c.f.m. per sq. ft. of cross-section

2) Inlet air temperature to bins - 140° F.

3) Depth of material in bins - 4 feet

4) Bulk density of semi-dried product - 23 lbs. per cu. ft.

5) Drying time - 6 hours

Figure 7 illustrates a suitable bin. Figure 8 illustrates a suggested arrangement for the bin room.

248.1 — Bin loading

It is assumed that each bin is loaded with approximately 1-1/2 hours' production (or 1,400 pounds of product). After the bins are loaded, they are connected to the hot-air duct to accomplish the final drying.

248.2 — Bin operating

It is anticipated that twelve bins will provide adequate capacity for plant production on the basis of six bins in the process of drying, one bin being loaded, one bin being unloaded, and four bins for holding. Space is provided for a total of six bins on the heated-air duct.

248.3 — Bin unloading

For unloading, one side of a bin is lifted by means of an electric hoist, and the contents dumped into the hopper feeding the screening operation.

250 — Screening and Inspecting

251 — Elevating

The dehydrated carrots are elevated from the hopper (248.3) to the screen by means of a gooseneck-conveyor.

252 — Screening

Military specifications require that not more than one percent by weight of the dehydrated product may pass through a U. S. Standard sieve containing eight meshes to the inch (0.0937 inch per opening). Screening is therefore necessary to remove the material that is too fine in size to comply with these requirements. A magnet is provided at this stage to remove any particles of iron or steel that may be in the dried product.

255 — Inspecting

After being screened, the dehydrated product is inspected for discolored pieces and other imperfections. The inspection is done while the dehydrated and screened product is carried along a continuous conveyor belt to the packaging operation.

260 — Packaging and Packing

261 — Filling, packing, and sealing

The rate of filling and handling the cans (330 per hour) is low for this type of operation, and expensive automatic equipment to fill and weigh the cans is not justified.

In the proposed filling operation, cans are fed manually into the can-run and then automatically placed in register with the can-filling openings. The entire can-carrying circular table revolves, as well as the center bowl carrying the product to be packaged. The product is manually brushed into the filling openings by the operators. The feed bowl is supplied from an overhead hopper through a gate which is opened and closed as required.

The filled cans are conveyed from the filling machine past two manual weighing stations and from there to a conventional can-closing machine. Specifications require that a printed leaflet giving cooking directions be placed in each can, or the directions be incorporated as part of the label on the exterior of the can.

Since the presence of oxygen causes undesired changes in the product during storage, military specifications require that "Every effort should be made to secure an oxygen content of less than one percent in the container". In order to accomplish this the air is replaced by inert gas as described in Chapter X of Volume I.

Cans should be purchased with lithographed labels as required in the specifications. The date is stamped on each can at the time of packing.

262 — Case forming, filling, sealing, and marking

Military specifications permit the use of either wood boxes or fiberboard cartons of definite types; the military bids and contracts will specify the exact types of packing to be supplied by the dehydrator. Present-day dehyrators use either mechanical or manual casing operations. Mechanical case-sealing has been provided in the proposed plant.

270 — Warehousing and Shipping

In keeping with the current trend, the proposed plant utilized pallets for handling and storing of the finished product in the warehouse.

GENERAL FACILITIES

The requirements for other needed facilities have been discussed in Volume I, and the information will not be repeated here. The principal "general" facilities for the carrot plant are listed in the "Cost of Facilities" for this proposed plant; included are items for utilities, maintenance and repairs, inspection and control, miscellaneous plant facilities, automotive, and administrative facilities and supplies.

325 — Waste Disposal

The waste material from the preparation line will be conveyed into an overhead hopper. This hopper should be located to permit trucks to back under the discharge chute to remove the trimmings. These solid wastes would most likely be used for stock feed, but they may have to trucked to a dump.

The screened liquid waste may be run into sewers, streams, irrigation ditches, seepage ponds, lagoons, or waste land, depending upon what is available and upon local or state regulations.

BUILDINGS AND GROUNDS

Buildings and grounds for a carrot dehydration plant should conform with the general requirements described in Volume I under "Plant Location" and "Selection of Plant Procedures and Facilities". A minimum of three acres of land should be provided for the carrot plant depicted herein; more acreage would be advisable in many cases.

Figure 3 shows a suggested plant layout. The various processing functions are located to permit expansion if such a step is necessary. The raw material storage area could expand away from the plant proper. Bin drying, inspection, and packaging operations could expand outside the original building. Finished product storage area could expand in two directions. The tunnel drying facilities could expand outside the building, the original design being such as to permit almost any number of tunnels to be added. Space for additional storage of trucks and trays could be provided in an extension of the building.

The space provided in the preparation room will permit some expansion with some rearrangement of the equipment. An additional trimming belt could be added, and a new blancher installed parallel to the present blancher and over the car tracks. The effective capacity of the present blancher could be increased somewhat by using heavier loading on the belt.

The boiler room is shown attached to the main building to permit a reasonably short length of steam pipes to the blancher. If the boiler is located at some distance from the plant, a saving in fire insurance rates might be possible but steam transmission losses would be higher.

The locations of the offices, laboratory, restrooms, and lunch room are only suggestive. These could be rearranged without seriously affecting plant operation.

Floor drains should be provided in the preparation area — particularly under the blancher (Code 227), washer (Code 225), trimming tables (Code 224) and along the tray loading and weighing line, and for each of the transfer tracks.

"Carrot Trimming Line"

(Courtesy of WESTERN CANNER AND PACKER)

CHAPTER IV

COST OF CARROT DEHYDRATION FACILITIES

Cost Summary

100 -- RAW MATERIAL PROCUREMENT FACILITIES		
170 -- "Crates, Boxes, & Sacks" (sacks)	$ 4,320	
Total for RAW MATERIAL PROCUREMENT FACILITIES		$ 4,320
200 -- MANUFACTURING OPERATIONS FACILITIES		
210 -- "Raw Material Handling" Equipment	16,560	
220-230 -- "Preparing" Equipment	75,745	
240 -- "Drying" Equipment	94,045	
250 -- "Screening & Inspecting" Equipment	4,100	
260 -- "Packaging & Packing" Equipment	20,375	
270 -- "Warehousing & Shipping" Equipment	6,880	
Total for MANUFACTURING FACILITIES		$217,705
GENERAL FACILITIES		
320 -- "Utilities" Equipment	30,430	
330 -- "Maintenance & Repairs" Equipment & Supplies .	15,000	
380 -- "Inspection & Control" Equipment	5,000	
390 -- "Miscellaneous Plant" Equipment	5,700	
400 -- "Automotive" Equipment	3,500	
690 -- "Office & First Aid" Equipment & Supplies . .	5,000	
Total for GENERAL FACILITIES		$ 64,630
Total for Plant Equipment (TABLE I)		$286,655
Total for Buildings & Grounds (TABLE II)		180,000
Construction Engineering Fees		30,000
TOTAL COST FOR ITEMIZED PHYSICAL FACILITIES FOR CARROT DEHYDRATION PLANT		496,655

Critical Materials in the Equipment for a 100-Ton per Day Carrot Dehydration Plant

Material	Estimated Total No. of Pounds in Equipment	Percentage of Total Weight of Critical Materials
Iron and Steel	195,000	98.1
Copper	1,600	0.8
Stainless Steel	1,000	0.5
Zinc	500	0.3
Tin	100	0.1
Rubber	350	0.2
Total	198,550	100.0

Disclaimer Statement

The designation of any manufacturer or brand-name equipment does not imply a specific recommendation by the Department of Agriculture. Such inclusion means only that these particular items have been found satisfactory for the purpose indicated; other sources and items may prove equally satisfactory. Additional information concerning suggested manufacturers of equipment may be found in "Additional Sources of Information" (Volume I, Appendix C).

TABLE I—PLANT EQUIPMENT FOR A 100-TON PER DAY CARROT DEHYDRATION PLANT
LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
			100 -- RAW MATERIAL PROCUREMENT FACILITIES			
170 -- Crate, Box & Sack Expense						
	a. Sacks: For handling carrots from field to plant	--	"Used" burlap sacks; 50 lbs. capacity.	24,000	$ 0.18 1/	$ 4,320
	TOTAL COST OF "RAW MATERIAL PROCUREMENT" FACILITIES					$ 4,320
			200 — MANUFACTURING OPERATIONS FACILITIES			
210 -- Raw Material Handling						
211 -- Weighing (at plant)						
	a. Truck scales: To weigh incoming loads of raw material (not required for plants having access to public scales)	Fairbanks-Morse Code 6512 (13,700 lbs)	Platform 10' x 60', capacity 50 tons; equipped with type registering beam; includes structural steel for timber deck. Cost includes $350 installation charge, and does not include pit	1	$ 3,750	$ 3,750
	b. Pit & housing for scales	--	Estimated cost for constructing pit and housing for scales	-	--	3,000
212 -- Unloading (at plant)						
	a. Lift truck: To unload and move palletized raw carrots and other loads within the plant	Yale Model KG 51-T-40-U (7,500 lbs)	Capacity 2 tons; gasoline engine	1	4,100	4,100
	b. Pallets: For handling raw carrots within plant	--	Wood; 48" x 60"; double faced	500	4	2,000
213 -- Feeding to line						
	a. Elevator: Serves as dumping point for sacked carrots, and elevates carrots to rod washer	FMC 2/ Fig. No. 5071 (1,100 lbs)	All steel construction; feed hopper; elevator and draper (24" wide x 9' discharge height) constructed of steel slats carried by side chain; complete with 1-1/2 h.p. motor	1	2,035	2,035
			Sub-total			$ 14,885
Allowance for Freight Charges (factory-made equipment)			-- 23,000 lbs. at 5¢/lb.			1,150
Allowance for Installation Charges -- 25% of equipment			cost plus freight ($2,090) 3/			525
	Total Cost of "Raw Material Handling" Equipment					$ 16,560
220-230 -- Preparing						
221 -- Washing						
	a. Dry washer: To remove loose dirt and debris without use of water	FMC Fig. 8758 (1,450 lbs)	36" diameter x 8' long rotary rod washer; complete with 2 h.p. motor	1	2,500	2,500
	b. Washer: To wash dirt from carrots	FMC Figure 8759 (2,100 lbs)	36" diameter x 12' long rotary rod type washer; all steel construction; with centrally located spray pipe, with adjustable discharge baffle; complete with 2 h.p. splash-proof motor drive	1	2,750	2,750
223 -- Peeling						
223.3 -- Steam peeling						
	a. Steamer: To loosen skins by subjecting carrots to high pressure steam	FMC Fig. 9274 (10,500 lbs)	Continuous high pressure steamer for maximum operating pressure of 100 p.s.i.; with feed elevator, platform for 6' discharge height, 3' extended shell, variable speed motor drive, and temperature control instruments	1	13,625	13,625

1/ Cost based on "used" sack price. If new sacks are purchased, the price is approximately 40¢/sack
2/ Food Machinery & Chemical Corp.
3/ Equipment cost based on F.O.B. manufacturer's price plus allowance for freight charges at 5¢/lb.

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
223.9 -- Washing						
a.	Washer: To wash loosened skins from raw carrots	FMC Fig. 8759 (2,100 lbs)	36" diameter x 12' long rotary rod type washer; all steel construction; with centrally located spray pipe; with adjustable discharge baffle; complete with 2 h.p. splash-proof motor drive	1	$ 2,750	$ 2,750
224 -- Trimming & inspecting						
a.	Conveyor belt: To convey and distribute washed carrots from the washer to trimming belts	FMC Fig. 5030 (1,000 lbs)	24" wide x 15' long center-to-center rubber belt distributing conveyor; steel frame construction; belt supported by steel rollers; complete with 1-1/2 h.p. motor drive	1	1,385	1,385
b.	Trimming belts: To supply washed and peeled carrots for final hand trimming	FMC Fig. 9318 (4,400 lbs each)	Merry-go-round trim tables consisting of 3 parallel 12" wide x 40' long (center-to-center) rubber belt conveyors, outer belts for trimming & with divided lanes for trimmings; inner belt to be raised so that return side acts as merry-go-round return for overflow from outer belts; top side for conveying trimmed product to discharge point; steel frame construction with belts carried on steel rollers; complete with 3 h.p. motor drive	2	5,455	10,910
c.	Conveyor: To collect trimmed carrots and convey for final inspection	FMC Fig. 5030 (1,100 lbs)	24" wide x 17' long (center-to-center) rubber belt conveyor; steel frame construction; belt supported by steel rollers; complete with 1-1/2 h.p. motor drive	1	1,475	1,475
226 -- Cutting (dicing)						
a.	Elevator: To elevate from inspection belt to dicers	FMC Fig. 8657 (1,550 lbs)	24" wide x 13' discharge height, cleated rubber belt elevator with steel frame; 1/2 h.p. constant speed motor drive	1	2,210	2,210
b.	Cutters (dicers): To cut prepared carrots to 3/8" x 3/8" x 3/16" size	Urschel Model B (750 lbs each)	Standard dicer; with one extra slicing knife, 6 extra circular knives, and 6 extra cross-cut knives; complete with 2 h.p. splash-proof motor drive.	3	1,410	4,230
227 -- Blanching and sulfiting						
a.	Blancher-sulfiter: To blanch and sulfite the diced product before drying	FMC Fig. 9332 (11,000 lbs)	Steam blancher, 50' overall length; with 6' wide stainless steel woven wire draper; with spray section at feed and discharge ends; complete with 5 h.p. variable speed motor drive	1	14,700	14,700
c.	Controls: To regulate and control temperatures in blancher	Taylor #86RV323 #6VP255 #12EU310 #R89S17 #R41S323 (125 lbs each set)	Each control set consisting of: Indicating temperature controller Reverse-acting diaphragm valve (1-1/4") Thermometers (120-220° F.) Air filter Air reducing valve (1/4")	2	275	550
d.	Sulfite make-up equipment: (1) Tanks: To mix and hold sulfite solution.	Inman Tank & Pipe & Cross Arm Co. (500 lbs ea.)	500-gallon -- 5'2" diameter x 4' high; Douglas fir construction	2	100	200
	(2) Sulfite pump: To deliver sulfite solution from storage to sprayers at discharge end of blancher	Tri-Clover Model 1-CR (100 lbs)	Centrifugal type sanitary pump; 1-1/4" x 1"; bronze; complete with 1/2 h.p. motor drive	1	110	110
			Sub-total			$ 57,395
Allowance for Freight Charges (factory-made equipment) -- 64,000 lbs. at 5¢/lb.						3,200
Allowance for Installation Charges -- 25% of equipment cost plus freight ($60,595)						15,150
	Total Cost of "Preparing" Equipment					$ 75,745
240 -- Drying						
241 -- Tunnel drying						
241.1 -- Tray loading						
a.	Tray conveyor: To convey empty trays under blancher to tray loader and tray stacker	Custom built (2,000 lbs)	6' wide x 25' long double chain conveyor; complete with 2 h.p. variable speed motor drive	1	2,300	2,300

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
b.	Tray loader: To load (and spread uniformly) the blanched carrots on the drying tray	Syntron Model F44 "Twin" (5,000 lbs)	Two 36" stainless steel troughs discharging to trays; equipped with magnetic vibrators	1	$ 2,000	$ 2,000
241.2	-- Tray stacking					
a.	Tray stacker: To stack loaded trays on cars	Knipschild Model (4,000 lbs)	Loaded trays are lifted vertically from tray conveyor and moved horizontally until positioned over empty car, then stacked to a height of 25 trays; fully automatic	1	3,600	3,600
241.3	-- Weighing					
a.	Scales: To weigh loaded cars	Toledo Model 31 1921 FE -- 76 x 54 FF (1,875 lbs)	Dial-type indicating system, 2,600 lb. capacity; platform 76" x 54"; equipped with extension lever to permit location of dial column out of path of cars; installed in pit with the scale-platform level with floor	1	980	980
241.4	-- Tunnel operating					
a.	Trays: To hold diced carrots during tunnel drying operations	--	6' long x 3' wide; wood frame and slat construction	3,200	3	9,600
b.	Tunnel driers: To dry diced carrots to approximately 8% moisture	Custom built (See Figures 5 & 6)	Twin tunnels, single stage counter-flow, 12-car length; equipped with necessary control equipment, trackage, cars, blower, furnace, etc.	4 twin tunnels	--	65,000 4/
241.5	-- Tray unloading & stacking					
a.	Tray unloader: To remove dried carrot dice from trays	Knipschild Model (1,500 lbs)	Trays are manually removed from trucks and turned over a revolving wire brush which loosens the carrots; carrots fall into hopper	1	1,400	1,400
241.6	-- Elevating and conveying					
a.	Elevator: To elevate dried carrot dice from discharge end of tray unloading hopper to bin loading hopper	FMC Fig. 542 (1,360 lbs)	Gooseneck conveyor-elevator; discharge height 10'; 16" wide buckets; complete with 1 h.p. motor drive	1	820	820
			Sub-total			85,700
Allowance for Freight Charges (factory-made equipment)			-- 16,000 lbs. at 5¢/lb.			800
Allowance for Installation Charges -- 25% of equipment			cost plus freight ($11,900)			2,975
	Total Cost of "Tunnel Drying" Equipment					$ 89,475
248	-- Bin drying					
248.1	-- Bin loading					
a.	Portable bins: To hold carrot dice during the final drying operation	Custom built (See Fig. 7)	3' wide x 5' long x 5' high; sheet metal or plywood construction; mounted on casters and equipped with ring for dumping by means of a hoist; metal screen to serve as false bottom; 12" diameter air duct	12	65	780
248.2	-- Bin operating					
b.	Blower: To circulate air through heating coils and drying bins	Sturtevant Silentvane No. 80 Design 10 Class II (875 lbs)	Single width; bottom horizontal discharge, 10,000 c.f.m. at 5" s.p.; equipped with 15 h.p. motor drive	1	1,000	1,000
c.	Heating coils: To heat air going into drying bins	Aerofin Corp. Type F Non-Freeze Coil, Series 80 (400 lbs)	Bank of coils 3 rows deep consisting of 18 tube face, 5'0" tube length	1	600	600
d.	Ductwork: To carry air from outside the building, conduct it through the fans and heating coils, and to each of the 6 drying bin positions	Custom built	Horizontal run laid on floor, 35' long, 10 sq. ft. cross-sectional area; 6 outlets on vertical side face spaced 5' center-to-center, and tapered to 12" diameter collars	1	1,250	1,250

4/ Cost installed - based on estimates from Bloxham Engineering Co., Basalt Rock Co., and other sources

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
248.3 -- Bin unloading						
a.	Hoist: To elevate the drying bins for dumping of the dried carrots	Yale Midget King Electric Hoist Model 1E 17H (140 lbs)	Hook type; 2,000 lb. capacity; 10' lift; 17 f.p.m.; 1 h.p.	1	$ 360	$ 360
			Sub-total			3,990
Allowance for Freight Charges (factory-made equipment) -- 1,400 lbs. at 5¢/lb.						70
Allowance for Installation Charges -- 25% of equipment cost plus freight ($2,030)						510
			Total Cost of "Bin Drying" Equipment			4,570
			Total Cost of "Tunnel Drying" Equipment			89,475
			Total Cost of "Drying" Equipment			$ 94,045
250 -- Screening and Inspecting						
251 -- Elevating						
a.	Elevator: To elevate product from hopper to shaker screen	FMC Fig. 542 (1,300 lbs)	Gooseneck conveyor; discharge height 8'; 16" wide buckets; 1 h.p. motor drive	1	775	775
252 -- Screening						
a.	Magnet: To remove tramp iron from product	FMC (Cesco) Plate Magnet (20 lbs)	Steel face plate 12" wide; standard model	1	90	90
b.	Shaker screen: To screen out "fines" from dried product	Link-Belt UP #125 (870 lbs)	2' x 5' unbalanced pulley type; one screen section on single deck; 2 h.p. motor drive	1	600	600
255 -- Inspecting						
a.	Conveyor-sorter: To convey the product past the final inspection station	FMC Fig. 5031 (1,300 lbs)	30" wide x 16' long (center-to-center) white rubber belt; steel frame construction; 1 h.p. motor drive	1	1,640	1,640
			Sub-total			3,105
Allowance for Freight Charges (factory-made equipment) -- 3,500 lbs. at 5¢/lb.						175
Allowance for Installation Charges -- 25% of equipment cost plus freight ($3,280)						820
			Total cost of "Screening and Inspection" Equipment			$ 4,100
260 -- Packaging and Packing						
261 -- Filling, packing, and sealing						
a.	Elevator: To elevate product to can-filling equipment	FMC Fig. 542 (1,000 lbs)	Gooseneck conveyor-elevator; 16" wide buckets; discharge height 6'; 1 h.p. motor drive	1	755	755
b.	Filling machine: To fill the product into #10 cans	FMC Handpack Filler Fig. 460-10 (1,500 lbs)	Product is fed into a hopper which rotates with the can-carrying table; stainless steel construction where in contact with product; complete with motor-driven vibrator and 1 h.p. motor drive	1	1,815	1,815
c.	Scales: To check-weigh exact amounts into cans	FMC Fig. 2150 (110 lbs each)	Model 1C-72-05 Detectogram general purpose scale; 10 lbs. capacity	2	115	230
f.	Vacuumizing & gassing unit: To replace air in filled cans with inert gas	American Can Co. (No. 3) (1,080 lbs each)	Consists of vacuum chamber holding 10 #10 cans; trays, gas expansion tank, filter, vacuum regulator, 3-way valve, and stand	3	955	2,865
f.	Vacuum pumps: To draw vacuum of 29.5" in vacuumizing and gassing units	Beach-Russ 100-D (1,500 lbs each)	Rotary piston type; rated capacity 115 c.f.m.; water cooled, dry vacuum type	2	1,340	2,680
f.	Gas piping assembly: To reduce pressure of gas from gas cylinders, provide gas storage at intermediate pressure, and convey gas to vacuumizing and gassing units	Custom built	Includes: high pressure manifold for 6 gas cylinders; 2 pressure-reducing valves; 1 intermediate pressure storage tank; and required pipe lines	1	300	300

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
g.	Can closing machine (seamer): To seal covers on cans	American Can Co. (No. 1) (1,050 lbs)	Semi-automatic machine operated by depressing foot treadle for each seaming operation; complete with 1-1/2 h.p. motor drive	1	$ 850	$ 850
h.	Can Conveyor: To convey filled cans past weighing station and to can-closing machine	FMC Special attachment to Can Filler (300 lbs)	7" wide x 8' leather belt conveyor	1	500	500
262 -- Case forming, filling, sealing, and marking						
a.	Case branding machine: To print required markings on cases	Elliott Manufacturing Co. (2,225 lbs)	Automatic machine equipped to handle box shook and flat fibre cases; complete with 1 h.p. motor and variable speed drive	1	1,980	1,980
b.	Case sealing machine: To seal top and bottom flaps on cases	Elliott Model A (4,000 lbs)	Fully automatic sealer with 16' of compression section; complete with 3/4 h.p. motor drive on gluing section and 3/4 h.p. motor drive on compression section	1	3,535	3,535
			Sub-total			$ 15,510
Allowance for Freight Charges (factory-made equipment) -- 17,000 lbs. at 5¢/lb.						850
Allowance for Installation Charges -- 25% of equipment cost plus freight ($16,060)						4,015
	Total Cost of "Packaging and Packing" Equipment					$ 20,375
270 -- Warehousing and Shipping						
271 -- Palletizing						
a.	Pallets: For handling empty cans and filled cans and cases	Custom built	Wood construction; 48" x 60"; double faced	600	4	2,400
272 -- Warehousing						
a.	Lift truck: For handling and transporting palletized loads in warehouse	Yale Model KG-51-T-40-U (7,300 lbs)	Capacity 2 tons; gasoline engine	1	4,080	4,080
			Sub-total			$ 6,480
Allowance for Freight Charges (factory-made equipment) -- 8,000 lbs. at 5¢/lb.						400
Allowance for Installation Charges						None
	Total of "Warehousing and Shipping" Equipment					$ 6,880
	TOTAL COST OF "MANUFACTURING OPERATIONS" FACILITIES					$217,705
	GENERAL FACILITIES					
320 -- Utilities						
321 -- Water supply						
a.	Water pump: To elevate water from well and to deliver it throughout plant at required pressure	FMC (Peerless) Deepwell Turbine-type Pump (5,300 lbs)	8 Stages, 10" M.A., Sheet No. R 1096, Curve 1; 500 g.p.m. with 285 ft. head at 80 p.s.i. delivery pressure; complete with strainer and 40 h.p. motor	1	2,000	2,000
b.	Chlorinator: To treat the water used in the plant to prevent slime formation and improve plant sanitation	Wallace & Tiernan Type MASVM-A-421 (1,500 lbs)	Consists of chlorinator, booster pump, differential converter, and main line orifice plate; converter automatically controls flow of chlorine so that the latter is always proportional to flow of water; equipped with 5 h.p. motor	1	4,500	4,500
c.	Water well: For supplying water sufficient to meet needs of the plant	--	Cost includes drilling and casing of well and small housing above it for pump motor	1	3,000	3,000

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
324 -- Steam supply						
a.	Steam boiler: To supply steam for operation of plant equipment, clean up, building heating, etc.	Cleaver-Brooks Model IR-400-15 (21,200 lbs)	Complete package unit: four-pass horizontal fire-tube boiler with integral channel iron frame and burner assembly; 150 boiler horsepower rating; 125 p.s.i. design pressure; equipped for burning gas and #6 oil; includes 7-1/2 h.p. blower motor, 1/3 h.p. spinner motor, 1/3 h.p. oil supply pump motor, feed pump and condensate tank	1	$ 9,200	$ 9,200
325 -- Waste disposal						
a.	Sewage screen: To separate solids from water in sewage disposal system	FMC Fig. 1437 North Sewage Screen (8,000 lbs)	Trunion type, with segment tooth drive; 6 ft. screen, #20-mesh bronze wire; 400 g.p.m. capacity; complete with steel tank and 3 h.p. motor drive	1	$ 3,095	3,095
b.	Elevator: To elevate solid waste from sewage screen to hopper	FMC Fig. 541 (2,100 lbs)	12" wide gooseneck conveyor-elevator with galvanized iron buckets; discharge height 20 feet; complete with 1 h.p. motor drive	1	880	880
c.	Waste hopper: To hold solid waste until trucked away	Custom built	10' long x 10' wide x 6' height, with sloping sides and discharge gate; elevated for clearance of 12 feet	1	400	400
			Sub-total			$ 23,075
Allowance for Freight Charges (factory-made equipment) -- 39,000 lbs. at 5¢/lb.						1,950
Allowance for Installation Charges -- 25% of equipment cost plus freight ($21,625)						5,405
	Total Cost of "Utilities" Equipment					$ 30,430
330 -- Maintenance & Repairs 5/						
a.	Maintenance shop equipment: To maintain plant in proper operating condition; to make necessary repairs	--	Includes welding and cutting equipment; drill presses; cut-off saws; sheet metal cutting facilities; hand tools for carpentry, electrical, and metal work; pipe threading and cutting equipment; miscellaneous supplies	-	--	5,000
b.	Maintenance parts & supplies: Standing inventory of spare parts and maintenance supplies to assure continuous operation of the plant	--	Pipe, sheet metal, fittings, electric motors, equipment parts, welding supplies, etc.	-	--	10,000
	Total Cost of "Maintenance & Repairs" Equipment and Supplies					$ 15,000
380 -- Inspection & Control 5/						
381 -- Laboratory testing						
a.	Laboratory equipment & supplies: To do necessary control testing of processing operations and of finished products	--	Apparatus, supplies, tables, hoods, benches, and other facilities needed for tests and control purpose	-	--	5,000
	Total Cost of "Inspection and Control" Equipment and Supplies					$ 5,000
390 -- Miscellaneous Plant Equipment 5/						
a.	Lunch room: To accomodate up to 50 people at a time	--	--	-	--	$ 4,500
b.	Fire-fighting equipment: For emergency use	--	2 - 300-ft. hoses & reels; 2 emergency showers; 8 - 5-gal. extinguisher tanks; 12 hand extinguishers; 12 gas masks	-	--	1,200
	Total Cost of "Miscellaneous Plant" Equipment					$ 5,700
400 -- Automotive Equipment						
a.	Truck: For miscellaneous hauling	GMC	1-1/2 ton pick-up truck (delivered price)	1	$ 3,500	$ 3,500
	Total Cost of "Automotive" Equipment					$ 3,500

5/ Costs indicated for these items include installation costs

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
690 -- Miscellaneous Administrative Supplies and Facilities 5/						
a.	Office furniture, supplies, and first-aid facilities: For bookkeeping, payrolls, business transactions; personnel work; first-aid	--	--	-	--	$ 5,000
	Total Cost of "Miscellaneous Administrative Supplies & Facilities"					$ 5,000
	TOTAL COST OF "GENERAL" FACILITIES					$ 64,630

TABLE II

BUILDINGS AND GROUNDS FOR A CARROT DEHYDRATION PLANT

	Building & Grounds: Suitable building and grounds for the carrot dehydration plant	--	Includes: land; and a building complete with industrial lights, utility and sewer lines within the building, toilet facilities, and loading ramps (or platform)			
			Building - 36,000 sq. ft. at $5/sq. ft.			$180,000
	TOTAL COST OF BUILDINGS AND GROUNDS					$180,000

TABLE III

OPTIONAL EQUIPMENT FOR A CARROT DEHYDRATION PLANT

321 -- Water supply 5/						
a.	Diesel engine: For standby use for operating the well water pump	Fairbanks-Morse Co.	Diesel engine complete with fuel tank and connecting gears for attaching to well water pump. Cost for this standby service is in addition to the cost of pump equipment listed	1	$1,500	$ 1,500
322 -- Fuel supply 5/						
a.	Butane storage tank: To supply standby fuel sufficient for 3 to 4 days of plant operation (tunnels, boiler, etc.) in case of emergency shutdown of regular gas supply; also to use in conjunction with "interruptible" type public gas service	--	26,600 gal. horizontal steel tank (Standard design) supplied by butane gas distributors: complete with vaporizor, pumps, controls, connecting piping to building, and supporting structure	1	20,000	20,000
394 -- Miscellaneous 5/						
a.	Hand trucks, auxiliary tables and other similar equipment	--	--	-	--	5,000
Allowance for Freight Charges (None)						None
	TOTAL COST FOR "OPTIONAL" FACILITIES					$ 26,500

5/ Costs indicated for these items include installation costs

Chapter V

PRODUCTION COSTS FOR A 100-TON PER DAY CARROT DEHYDRATION PLANT

Table I -- Summary of Cost of Producing Dehydrated Carrots
(Assuming Different Raw Material Costs and Shrinkage Ratios)

Overall-shrinkage ratio of:		9 to 1	11 to 1	15 to 1
Output of finished product per day (lbs.)		22,220	18,200	13,340
		Production Cost per Pound of Product		
Processing Cost - See Table II		$0.2538	$0.2884	$0.3579
Assumed Cost per 100 tons of Raw Material Entering Processing Line				
At $10 a ton	$1,000 a day	$0.0450	$0.0550	$0.0750
15	1,500	0.0675	0.0825	0.1125
20	2,000	0.0900	0.1100	0.1500
25	2,500	0.1125	0.1375	0.1875
30	3,000	0.1350	0.1650	0.2250
40	4,000	0.1800	0.2200	0.3000
Assumed Production Cost at Various Costs of Raw Material 1/				
At $10 a ton		$0.2988	$0.3434	$0.4329
15		0.3213	0.3709	0.4704
20		0.3438	0.3984	0.5079
25		0.3663	0.4259	0.5454
30		0.3888	0.4534	0.5829
40		0.4338	0.5084	0.6579
Estimated Depreciation Charge (See Table X)				
Normal life expectancy		$0.0055	$0.0067	$0.0091
Accelerated write-off		0.0149	0.0181	0.0247

1/ Exclusive of depreciation charges

Table II -- Processing Cost Summary Using 3 Different Overall Shrinkage Ratios
(Depreciation not included)
(Carrot Dehydration Plant)

	9 to 1 (Low)	11 to 1 (Average)	15 to 1 (High)
Input - lbs. per day raw commodity	200,000	200,000	200,000
Output - lbs. per day net yield of carrot dice	22,220	18,200	13,340
Total daily processing cost based upon cost calculation using an 11 to 1 overall shrinkage ratio	$5,249	$5,249	$5,249
Adjustment for labor -			
Add 22% of labor cost of $684 for screening and inspecting, packaging & packing, and warehousing & shipping	+150		
Deduct 27% of labor cost of $684 for screening & inspecting, packaging & packing, and warehousing & shipping			- 185
Adjustment for packaging supplies -			
Deduct total packaging supply cost based on an 11 to 1 ratio (see Table III)	- 1,088		- 1,088
Add cost applicable to shrinkage ratio (pounds x $0.0598)	+ 1,329		+ 798
Adjusted cost 1/	$5,640	$5,249	$4,774
Cost per pound of net product	$0.2538	$0.2884	$0.3579

1/ For purposes of this illustration, it is assumed that all costs per day would be constant for the various yields except the two cost items adjusted. In actual practice, however, costs would be more variable as a result of the different shrinkage ratios

Table II-A -- Calculation of Unit Costs of Processing for Various Shrinkage Ratios
(Assuming constancy of cost except as calculated in Table II)

	9 to 1		11 to 1		15 to 1	
	Daily Cost	per Pound	Daily Cost	per Pound	Daily Cost	per Pound
Pounds output per day	12,220		18,200		13,340	
Raw material procurement	$ 68	$0.0031	$ 68	$0.0037	$ 68	$0.0051
Direct labor cost	3,256	0.1465	3,106	0.1707	2,921	0.2190
Manufacturing expense	2,010	0.0904	1,769	0.0972	1,479	0.1109
Packaging supplies and expenses	1,329	0.0598	1,088	0.0598	798	0.0598
Other manufacturing expenses	681	0.0306	681	0.0374	681	0.0511
General and Administration Expense	306	0.0138	306	0.0168	306	0.0229
Total	$5,640	$0.2538	$5,249	$0.2884	$4,774	$0.3579

Table III -- Processing Cost Summary for Carrot Dehydration Plant

Account No.		Table No. Reference	Processing Cost Per 24-hour Operating Day	Processing Cost Per Pound Dry Product
Output of Finished Product Per Day (11 to 1 overall shrinkage ratio)		II	18,200 pounds	
800 -- Total Cost of Finished Product (exclusive of depreciation and raw material purchase price)			$5,249	$0.2884
100 -- Raw Material Cost (exclusive of purchase price)		IV	$ 68	$0.0037
120	- Buying expense		38	0.0021
180	- Federal-State Inspection		30	0.0016
200 -- Direct Labor		V	$3,106	$0.1707
210	- Raw Material Handling		196	0.0108
220-230	- Preparing		1,710	0.0940
240	- Drying		516	0.0283
250	- Screening and Inspecting		330	0.0181
260	- Packaging and Packing		298	0.0164
270	- Warehousing and Shipping		56	0.0031
300 -- Manufacturing Expense			$1,769	$0.0972
310	- Indirect Labor	VII	166	0.0091
320	- Utilities	VIII	196	0.0108
330	- Maintenance and Repairs	IX	137	0.0075
340	- Depreciation (not included)	X	---	------
350	- Taxes and Insurance	XI	50	0.0027
370	- Packing Supplies and Expenses	XII	1,088	0.0598
380	- Inspection and Control	XIII	72	0.0040
390	- Miscellaneous Plant Expenses	XIV	60	0.0033
600 -- General & Administrative Expenses		XV	$ 306	$0.0168
610	- Office Salaries		131	0.0072
620-690	- Miscellaneous Expenses		175	0.0096

Table IV -- Raw Material Cost (Account 100)
(Carrot Dehydration Plant)

Account No.			Annual Cost	Cost per Operating Day 1/
100 -- Total Raw Material Cost (excluding purchase price of raw material)			$16,956	$68
110 - Purchase Price			------	---
The purchase price of raw material is not included here as a cost. See Table I for calculation of raw material costs at various purchase prices per ton				
120 - Buying Expense			9,456	38
Salary of field agent	$7,000			
Social security, workmen's compensation and unemployment insurance - 6.52%	456			
Expenses - Travel, telephone, etc. (estimated)	2,000			
150 - Transportation and Weighing Costs			-----	---
(Included in Table I as part of assumed prices paid for raw material)				
160 - Storage - None			-----	---
170 - Crate, Box, and Sack Expense			-----	---
Cost not included here. On the basis of a cost of $4,320 for sacks and a half-year life, the annual charge would be $8,640				
180 - Federal-State Inspection			7,500	30
One inspector 250 days @ $30.00				

1/ 250 operating days per year

Table V -- Direct Labor Cost Summary (Account 200)
(Carrot Dehydration Plant)

Account No.		Per 24-Hour Operating Day: Direct Labor Cost per Day 1/	Add Labor Expense 22.25% 2/	Total Direct Labor Cost
200	-- Total Direct Labor Cost	$2,540	$565	$3,105
210	- Raw Material Handling	160	36	196
220-230	- Preparing	1,399	311	1,710
240	- Drying	422	94	516
250	- Screening and Inspecting	270	60	330
260	- Packaging and Packing	243	54	297
270	- Warehousing and Shipping	46	10	56

1/ From Table VI

2/ In addition to the "Direct Labor Cost per Day" the following items are additional costs that must be paid by the employer:

		Percentage to apply to Calculated Labor Cost
a.	Overtime - All hours per week over 40 are paid for at one-and-one-half times the basic rate. The work week is 48 hours, making 8 hours to be paid at overtime. For the week he gets 52 hours pay for 48 hours work (52/48) - 1.0 = 0.08333	8.33%
b.	Swing and night shift differential may amount to 5¢/hr. At an average hourly labor rate of $1.28, the differential is 3.90% on two shifts, or an average of 2.60% on a three shift basis	2.60
c.	Social security - paid by employer	1.50
d.	Unemployment insurance - for a new, highly seasonal business, the rate would be	2.70
e.	Workmen's compensation insurance	2.32
f.	Vacation pay - one week's pay for employees who work over 1600 hours 6/250	2.40
g.	Holoday pay - 6 holidays estimated 6/250	2.40
	Total	22.25%

Table VI -- Direct Labor Cost Work Sheet (Account 200)
(Carrot Dehydration Plant)

Account No.	Operation	Number of Employees per Shift		Hourly Rate of Pay		Total Hours per Shift	Total Cost per Shift	Total Cost per 24-hour Operating Day
		Men	Women	Pay Bracket	Amount			
200	-- TOTAL DIRECT LABOR COST	18	67				$846.77	$2,540.32
210	-- Raw Material Handling	4 1/2	-				$ 53.44	$ 160.32
	Foreman 1/	1/2		1	$1.90	4	7.60	
	Operating lift truck	1		3	1.55	8	12.40	
	Feeding line	2		4	1.42	16	22.72	
	Cleaning up, handling empty sacks, etc.	1		5	1.34	8	10.72	
220-230	- Preparing	2 1/2	46				466.24	1,398.72
	Foreman 1/	1/2		1	1.90	4	7.60	
	Floorlady		1	5	1.34	8	10.72	
	Trimming		45	6	1.18	360	424.80	
	Operating slicers and blancher	1		3	1.55	8	12.40	
	Cleaning up	1		5	1.34	8	10.72	
240	-- Drying	6	8				140.77	422.32
241	-- Tunnel drying	4 1/2	8				120.77	362.32
	Foreman 2/	1/2		1	1.90	4	7.60	
	Feeding trays to tray loading		2	6	1.18	16	18.88	
	Loading and spreading on trays		2	6	1.18	16	18.88	
	Tray stacking and truck weighing	1		4	1.42	8	11.36	
	Operating tunnels	2		4	1.42	16	22.72	
	Feeding tray scraper		2	6	1.18	16	18.88	
	Restacking trays		2	6	1.18	16	18.88	
	Sub-total	3 1/2	8				117.20	351.60
	Sundays only - Washing trays 3/	(5)		5	1.34	40	53.60	
	Repairing trays 3/	(1)		5	1.34	8	10.72	
	Sub-total - Sundays only	(6)					64.32	10.72
248	-- Bin drying	1 1/2					20.00	60.00
	Foreman 2/	1/2		1	1.90	4	7.60	
	Handling bins	1		3	1.55	8	12.40	
250	-- Screening and Inspecting	3/4	8 1/2				90.04	270.12
	Foreman 4/	1/4		1	1.90	2	3.80	
	Floorlady 5/		1/2	5	1.34	4	5.36	
	Inspecting		8	6	1.18	64	75.52	
	Cleaning up 6/	1/2		5	1.34	4	5.36	
260	-- Packaging and Packing	3	4 1/2				81.12	243.36
	Foreman 4/	1/2		1	1.90	4	7.60	
	Floorlady 5/		1/2	5	1.34	4	5.36	
	Feeding and filling cans		1	6	1.18	8	9.44	
	Check weighing cans		1	6	1.18	8	9.44	
	Sealing and traying for gassing		1	6	1.18	8	9.44	
	Vacuumizing and gassing	1		3	1.55	8	12.40	
	Soldering hole in lid and casing		1	5	1.34	8	10.72	
	Strapping and stacking cases	1		4	1.42	8	11.36	
	Cleaning up 6/	1/2		5	1.34	4	5.36	
270	-- Warehousing and Shipping	1 1/4	-				15.16	45.48
	Foreman 4/	1/4		1	1.90	2	3.80	
	Storing, carloading, etc.	1		4	1.42	8	11.36	

1/ One foreman for raw material handling and preparing
2/ One foreman for all drying operations
3/ Tray washing and repairing done on Sundays only - charge 1/6 of cost to each operating day
4/ One foreman for screening & inspecting, packaging, and warehousing & shipping
5/ One floorlady for inspecting and packaging
6/ One cleanup man for screening & inspecting, and packaging

Table VII -- Indirect Labor (Account 310)
(Carrot Dehydration Plant)

Account No.		Number of Employees	Assumed Yearly Rate	Hourly Rate	Total No. of Hours Employed Annually 1/	Yearly Cost	Cost per Operating Day
310 -- Total Indirect Labor						$41,450	$166
	Year-round employees					$28,760	
	Production Supt.	1	$7,000	-	-	$7,000	
	Shift Superintendents	2	6,000	-	-	12,000	
	Guards	---	-----	--	-	8,000 2/	
	Labor expense - 6.52% 4/					1,760	
	Seasonal employees					12,690	
	Boiler operator and oiler	3		$1.73	6,000 3/	10,380	
	Labor expense - 22.25% 5/					2,310	

1/ 250 days a year

2/ The estimate of $8,000 for guard service is based upon an assumption of 16 hours guard service per day for each day of the year. The number of guards actually employed will depend upon how the guard time is divided among the guards. For example, in a week of 7 days, 16 hours a day, or a total of 112 hours, three guards could divide the time so that each would work about 37 hours

3/ 250 days, 24 hours a day - 6,000 hours

4/ Social security 1.50%
Unemployment insurance 2.70
Workmen's compensation 2.32
6.52%

5/ See Table V for analysis of 22.25% labor expense

Table VIII -- Utilities (Account 320)
(Carrot Dehydration Plant)

Account No.			Cost per Operating Day
320 -- Total Daily Cost of Utilities			$196
321 -- Water Supply			---
400 gallons per minute is estimated need of plant. It is assumed water will be pumped from company's own well, so cost of pumping is included in power cost			
322 -- Fuel - Gas			151
Boiler		Cu.ft. per day	
75% use factor x 150 boiler horsepower x 33,500 B.T.U. x 24 hours / 80% efficiency x 1,000 B.T.U./cu.ft. =		113,000	
Drying Tunnels			
40,000 c.f.m. x 60 min. x 24 hours x (160°-60°) x .24 x 4 tunnels / 15.6 cu.ft./lb. x 1,000 B.T.U./cu.ft. =		354,000	
Add 10% for losses in tunnel		35,000	
Total fuel per day - cu.ft. of gas		502,000	
Cost per day - 502,000 x $.30/1,000 cu.ft. = ($0.30 is approximate "Interruptible Natural Gas" rate in California. Standby service, such as tank gas, would be desirable)		$150.60	
323 -- Electric Power			45
		K.W.	
Motors - 260 h.p. (746 watts per h.p. and 75% use and efficiency factor)		146	
Lights		40	
Total electric power		186	
Cost per hour @ 1¢ per k.w.h.		$1.86	
Cost per day $1.86 x 24 hours	$44.64		
325 -- Waste Disposal			---
Garbage Disposal - No cost. Trimmings and screened waste should have some value for cattle feed and be hauled away by farmers at no cost to plant			
Sewage Charges - None Assumed disposal in rural area			

Table IX -- Maintenance and Repairs (Account 330)
(Carrot Dehydration Plant)

	Total No. of Employees	Hourly Rate Pay Bracket	Hourly Rate Amount	Hours Worked Process Season 1/	Hours Worked Off Season 2/	Total per Employee	Hours for Group	Total Cost Per Year
Labor 3/								
Head mechanic	1	1	$1.90	2,000	400	2,400	2,400	$ 4,560
Shift mechanic and oilers	3	2	1.73	2,000	400	2,400	7,200	12,456
Maintenance mechanic	1	3	1.55	2,000	400	2,400	2,400	3,720
Sub-total	5							$20,736
Add labor expense - 16.43% 4/								3,407
						Labor Cost		$24,143
Cost of Supplies and Replacements								
Estimated (for entire year)								10,000
Total Cost of "Maintenance and Repairs" for a year								$34,143
Cost per operating day ($34,143/250)								$137

1/ 250 days - 8 hours a day = 2,000 hours

2/ 10 weeks - 50 days - 8 hours a day = 400 hours (includes vacation and holiday pay)

3/ All mechanics will be employed in off-season on maintenance and repair work

4/ Labor expense during processing season 18.41%

Night shift differential: 2 mechanics out of 5 on night shift. At average hourly rate of $1.73, 5¢ an hour differential (2.90% x 2/5)	1.16%
Social security	1.50
Unemployment insurance	2.70
Workmen's compensation	2.32
Vacation pay (included in time for off-season)	----
Holiday pay (see Table V)	2.40
Overtime - 52 hours pay for 48 hours work (see Table V)	8.33

Labor expense during off-season 6.52%

Social security	1.50%
Unemployment insurance	2.70
Workmen's compensation	2.32
Vacation and holiday pay included in regular 40-hour week . . .	----

Calculation of labor expense percentage to apply:

(2,000 hours @ 18.41%) 2,000 x 0.1841 = 368.20

(400 hours @ 6.52%) 400 x 0.0652 = 26.08

394.28

$\frac{394.28}{2,400}$ = 16.43%

Table X -- Depreciation (Account 340)
(Carrot Dehydration Plant)

Depreciation is not included as a cost because of the uncertainty of the write-off period that may be allowed. (See "Business Considerations" in Volume I.) The depreciation charges that would be incurred in this plant are calculated below for two possible write-off periods:

1. Assuming normal life expectancy and probable useful lives (as given in Bulletin F, U.S. Treasury Dept., Bureau of Internal Revenue)

Property Item	Original Cost 1/	Estimated 10% Salvage Value	Cost to be Depreciated	Useful Life (years)	Annual Depreciation Charge
Building and Grounds	$185,000	$18,500 2/	$166,500	50	$ 3,330
Burlap Sacks	4,320	-----	4,320	1/2	8,640
Equipment	307,335	30,730	276,605	15	18,440
Total	$496,655	$49,230	$447,425		$30,410

Depreciation Charges:

Per operating day ($30,410/250)	$122
Per lb. of product at 9:1 ($122/22,220)	$0.0055
Per lb. of product at 11:1 ($122/18,200)	0.0067
Per lb. of product at 15:1 ($122/13,340)	0.0091

2. Assuming 5-year write-off of 75% of capital investment

Total capital investment	$496,655
Less sack cost	4,320
	$492,335
75% to be written off	$369,250
Annual charge ($369,250/5)	$ 73,850
Add depreciation on sacks	8,640
Total depreciation charge	$ 82,490

Depreciation Charges:

Per operating day ($82,500/250)	$330
Per lb. of product at 9:1 ($330/22,220)	$0.0149
Per lb. of product at 11:1 ($330/18,200)	0.0181
Per lb. of product at 15:1 ($330/13,340)	0.0247

1/ Includes Engineering Construction fees (Buildings and Grounds $5,000; Equipment $25,000)

2/ Includes value of land not depreciated

Table XI -- Taxes and Insurance (Account 350)
(Carrot Dehydration Plant)

Account No.		Cost per Operating Day
350	-- Taxes and Insurance Expense	$50
	For purposes of this estimate, taxes and insurance on property are combined.	
	Estimated cost of facilities $500,000	
	Taxes and insurance at 2 1/2% $12,500	
	Cost per operating day ($12,500/250)	$50

Table XII -- Packing Supplies and Expenses (Account 370)
(Carrot Dehydration Plant)

Account No.		Cost per Operating Day
370	-- Total Packing Supplies and Expenses	$1,088
	Cans	
	Allowing 2 3/4 pounds carrot dice per No. 10 can	
	18,200 daily output/2.75 = 6,620 cans per day @ $99/M	$ 656
	Cases	
	1,104 per day (6 cans per case) @ $299.25/M	330
	Supplies	
	Straps, glue, recipe sheets, etc. @ 1¢/can	66
	Nitrogen - for gas pack	
	2,000 cu.ft. per day @ $1.25/100 cu.ft. . . . . ($1.00 per hundred cu.ft. for nitrogen .25 per hundred cu.ft. for freight and cylinder return)	25
	Allowance for losses (1% of $1,077)	11

Table XIII -- Inspection and Control (Account 380)
(Carrot Dehydration Plant)

Account No.			Annual Cost	Cost/Operating Day
380 -- Total Cost, Inspection and Control			$17,926	$72
Salaried Employees:				
Quality Control Technologist		$6,000		
Add labor expense (6.52%)		391	$6,391	
Hourly Employees:				
3 laboratory technicians @ $1.30/hr (6,000 hrs.)		$7,800		
Labor expense (22.25%)		1,735	9,535	
Supplies & Other Miscellaneous Expenses			2,000	

Table XIV -- Miscellaneous Plant Expenses & Income (Account 390)

Account No.	Cost/Operating Day
390 -- Miscellaneous Plant Expense	$60
391 - Lunch room operation - Assumed that sales of meals would offset the lunch room expense	---
392 - Chemicals - 200 pounds of sulfate per day @ 5¢/lb.	10
393 - Sales of trimmings, fines, etc. Some return might be realized from the sale of "fines" for soup stocks, and perhaps from the sale of "rejects" from final inspecting and trimmings for cattle feed. No return is assumed, here, however.	---
394 - Other miscellaneous costs (estimated)	50

Table XV -- General and Administrative Expense (Account 600)

Account No.	Cost/Operating Day
Estimated at 4% of a production cost of 42¢/lb.	$306
(18,200 lbs. x 42¢ x 4%) = $305.76	
Annual cost ($306 x 250) = ...	$76,500

This estimate is consistent with World War II experience when dehydrators reported General and Administrative Expense ranging from 1% to 15% of total production cost, and averaging between 4% and 5%. This annual cost might be made up as follows:

610 - Salaries	General Manager	$10,000		
	Office manager	6,000		
	Personnel officer	4,800		
	Clerks (4 @ $3,000)	12,000	$32,800	
	Labor expense (6.52%)		2,140	$34,940
620-690 - Other expenses				41,560
				$76,500

CHAPTER VI

SUMMARY OF CAPITAL AND CREDIT REQUIREMENTS FOR A 100-TON PER DAY CARROT DEHYDRATION PLANT

Fixed Capital and Credit Requirements:			
Plant Equipment		$287,000	
Buildings and Grounds		180,000	
Construction Engineering Fees		30,000	
6-Month General Expense: (From "Production Costs")			
From Table IV - Raw Material Procurement	$4,800		
From Table XIII - Inspection & Control	8,900		
From Table XV - General Administration	38,300	52,000	$549,000
Operating Capital and Credit Requirements:			
Estimated Advance Payments to Growers, Insurance, Utilities, etc.		$25,000	
75-day Operating Costs ($7,700/operating day) 1/		573,500	
25-day Inventory of Manufacturing Supplies (exclusive of raw commodity) ($1,100/operating day)		27,500	626,000
Sub-total			$1,175,000
General Contingency Fund:			
Equivalent to approximately 10% of Estimated Capital Requirements			120,000
ESTIMATED TOTAL CAPITAL AND CREDIT REQUIREMENTS			$1,295,000

1/ Based on 18,200 lbs. dehydrated carrot dice per day at an approximate cost of 42¢/lb.

FIG. 1 USUAL PLANTING AND HARVESTING PERIODS FOR CARROTS IN PRINCIPAL PRODUCING STATES.

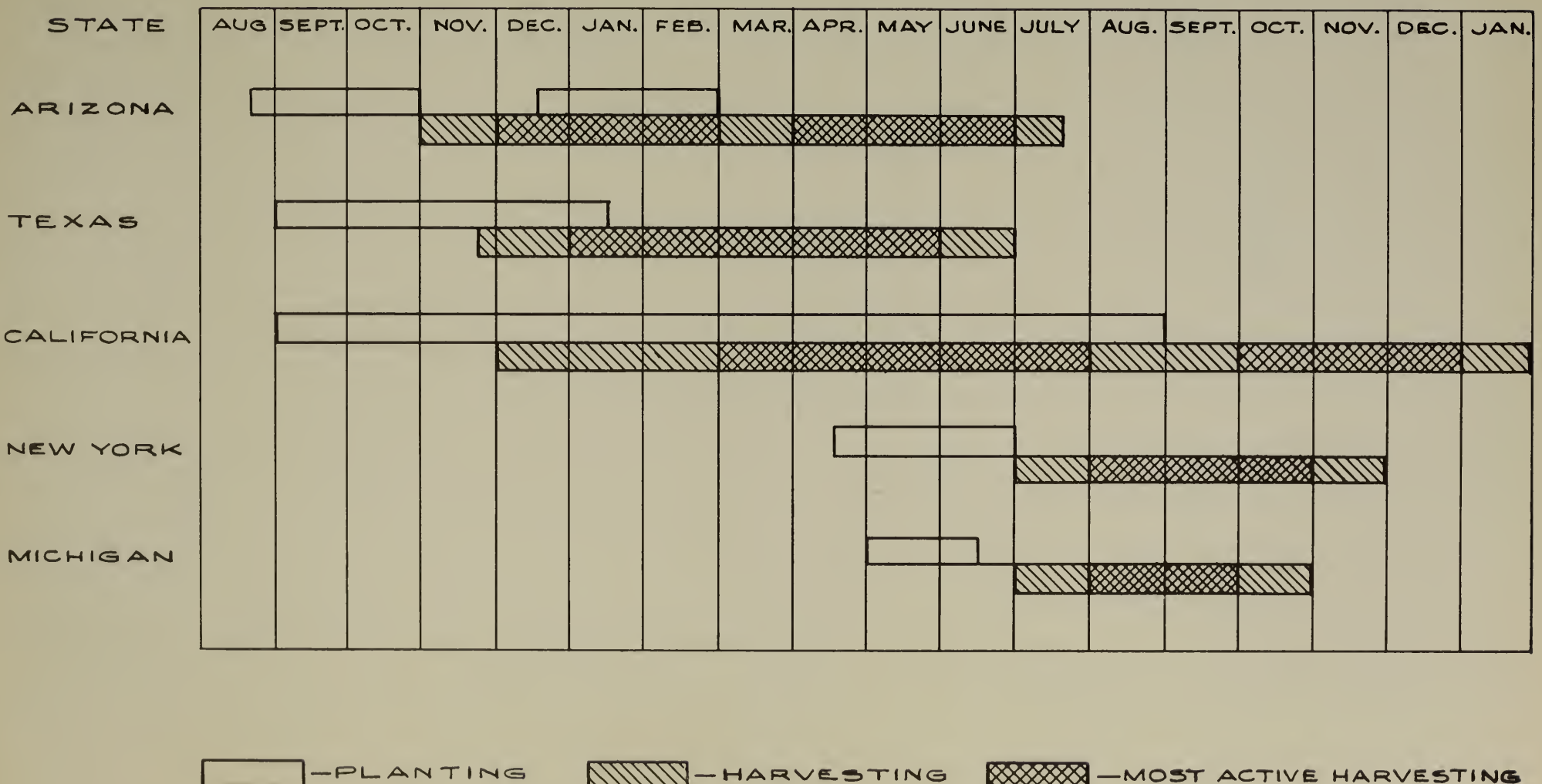
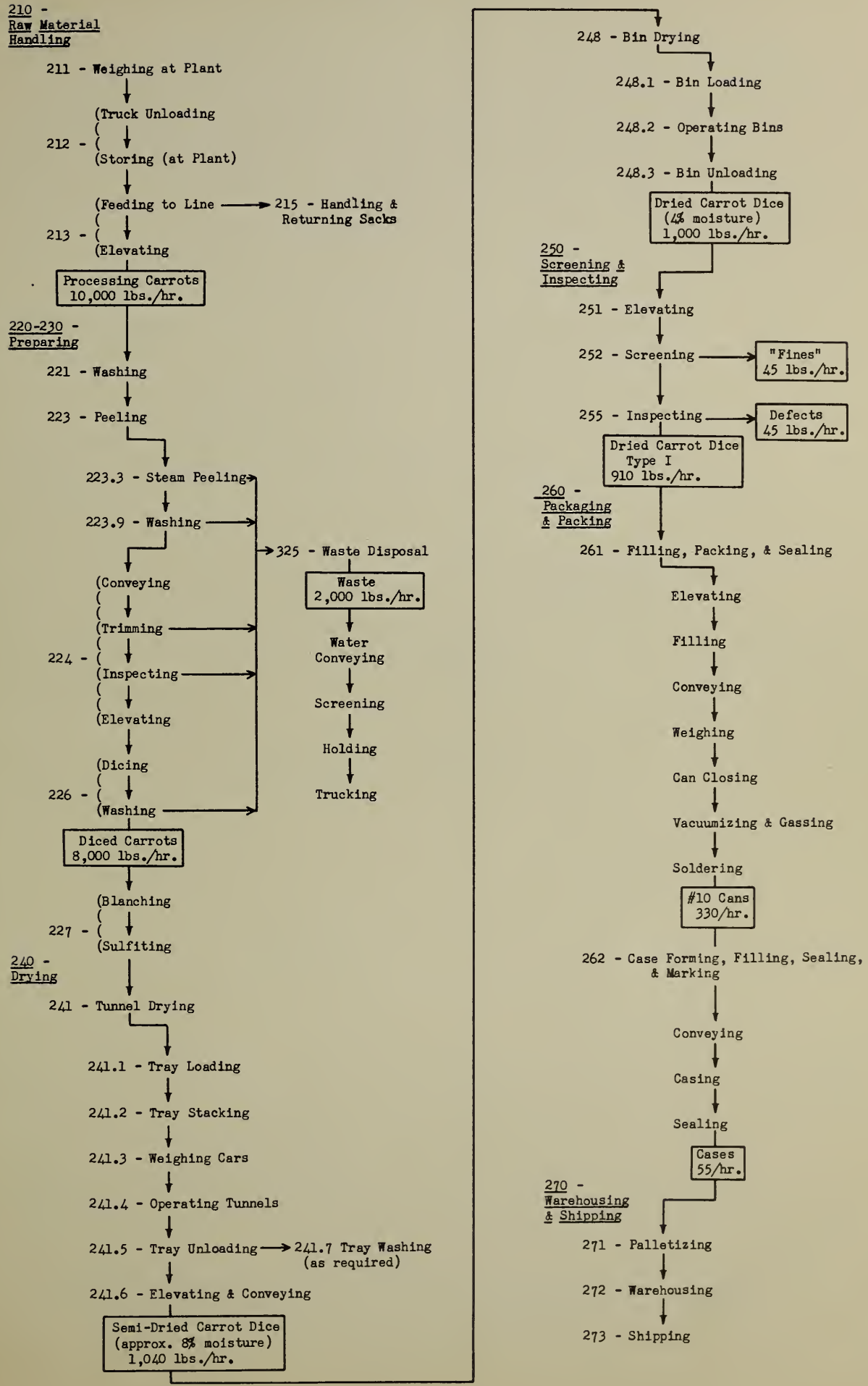


Figure 2 - FLOW SHEET FOR CARROT DICE DEHYDRATION
(Capacity - 100 Raw Tons per Day)



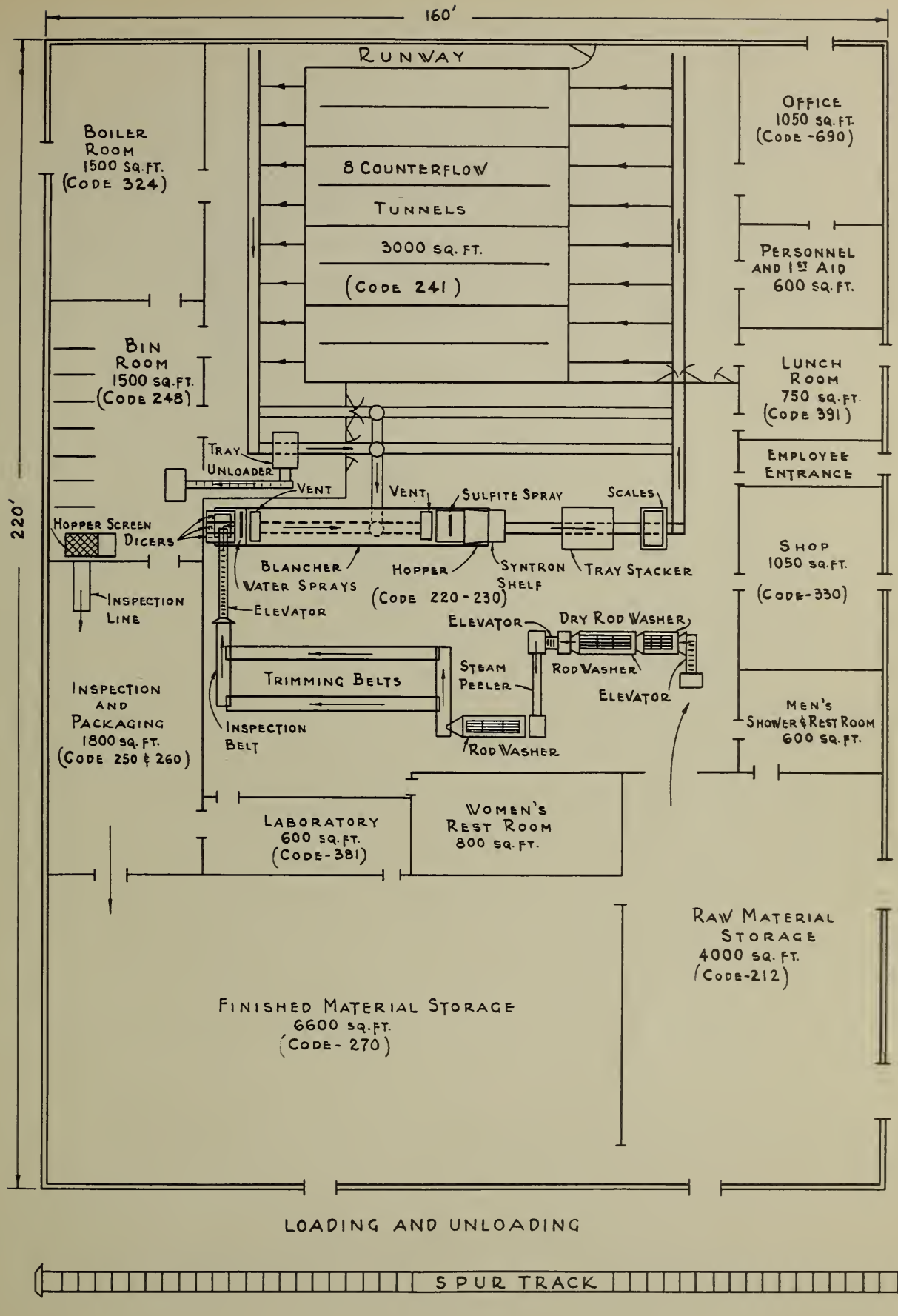


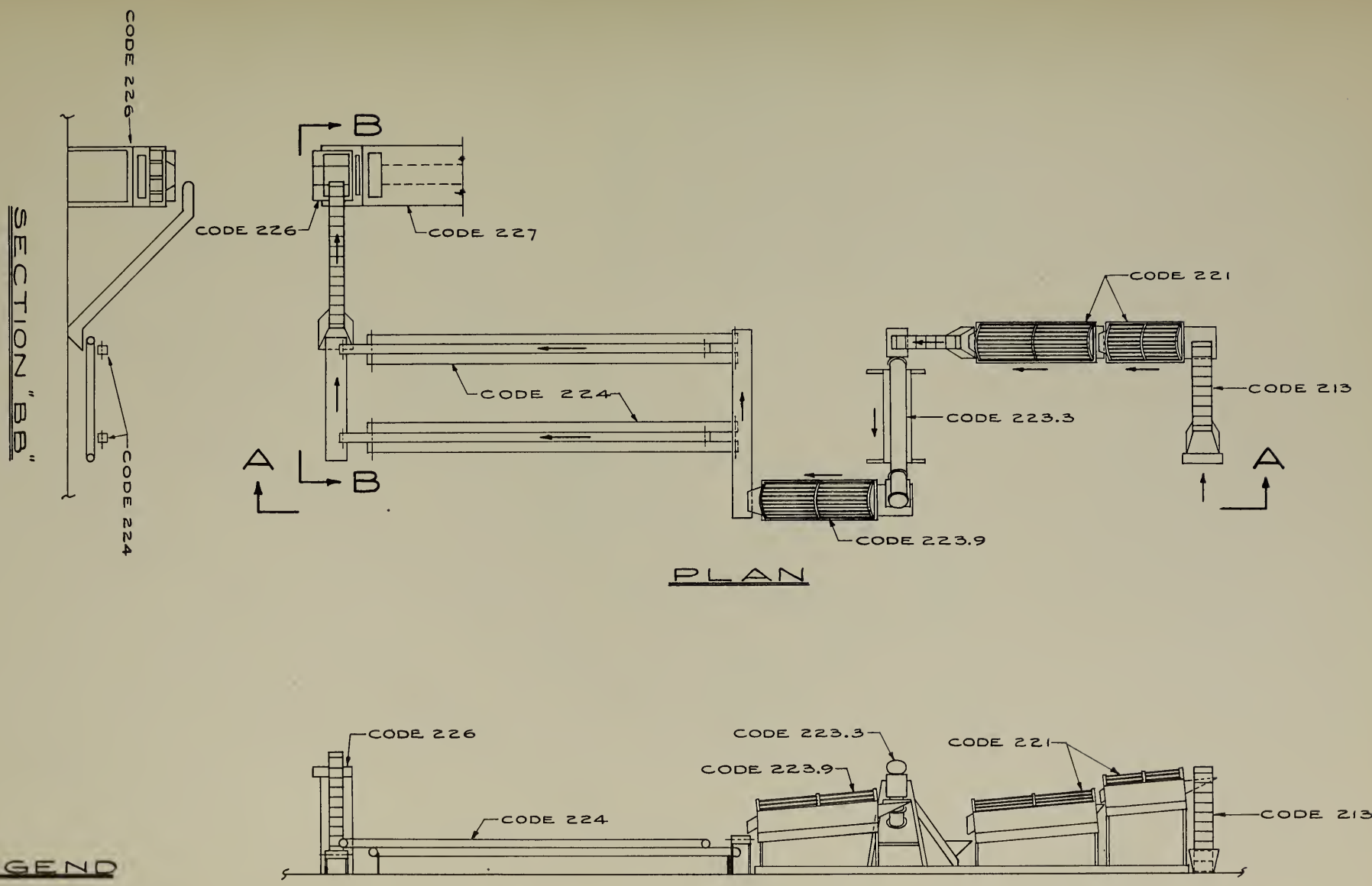
FIGURE No 3

PROPOSED FLOOR PLAN FOR CARROT DICE DEHYDRATING PLANT

AREA APPROXIMATELY 36,000 SQ. FT.

0 5 15 25

SCALE: 1" = 16'



LEGEND

CODE 213 ELEVATOR
221 DRY AND WET ROD WASHER
223.3 STEAM PEELER
223.9 WASHER
224 TRIMMING BELTS
226 DICERS
227 BLANCHER

FIGURE 4

PREPARATION LINE FOR CARROT DEHYDRATION PLANT

GENERAL NOTES.

1. DAMPER TO REGULATE FLOW OF FRESH AIR
2. COMBUSTION CHAMBER
3. BLOWER
4. SHUT-OFF DAMPERS (TWO)
5. SPLITTER DAMPER
6. DAMPERS TO REGULATE FLOW OF RECIRCULATING AIR (TWO)
7. EXHAUST STACKS (TWO)
8. ENTRANCE AND EXIT DOORS (2 SETS)
9. TRAYS OF DRIED PRODUCT LEAVING TUNNEL (ON TRUCKS)
10. TRACKS THROUGH TUNNEL FOR TRUCKS.

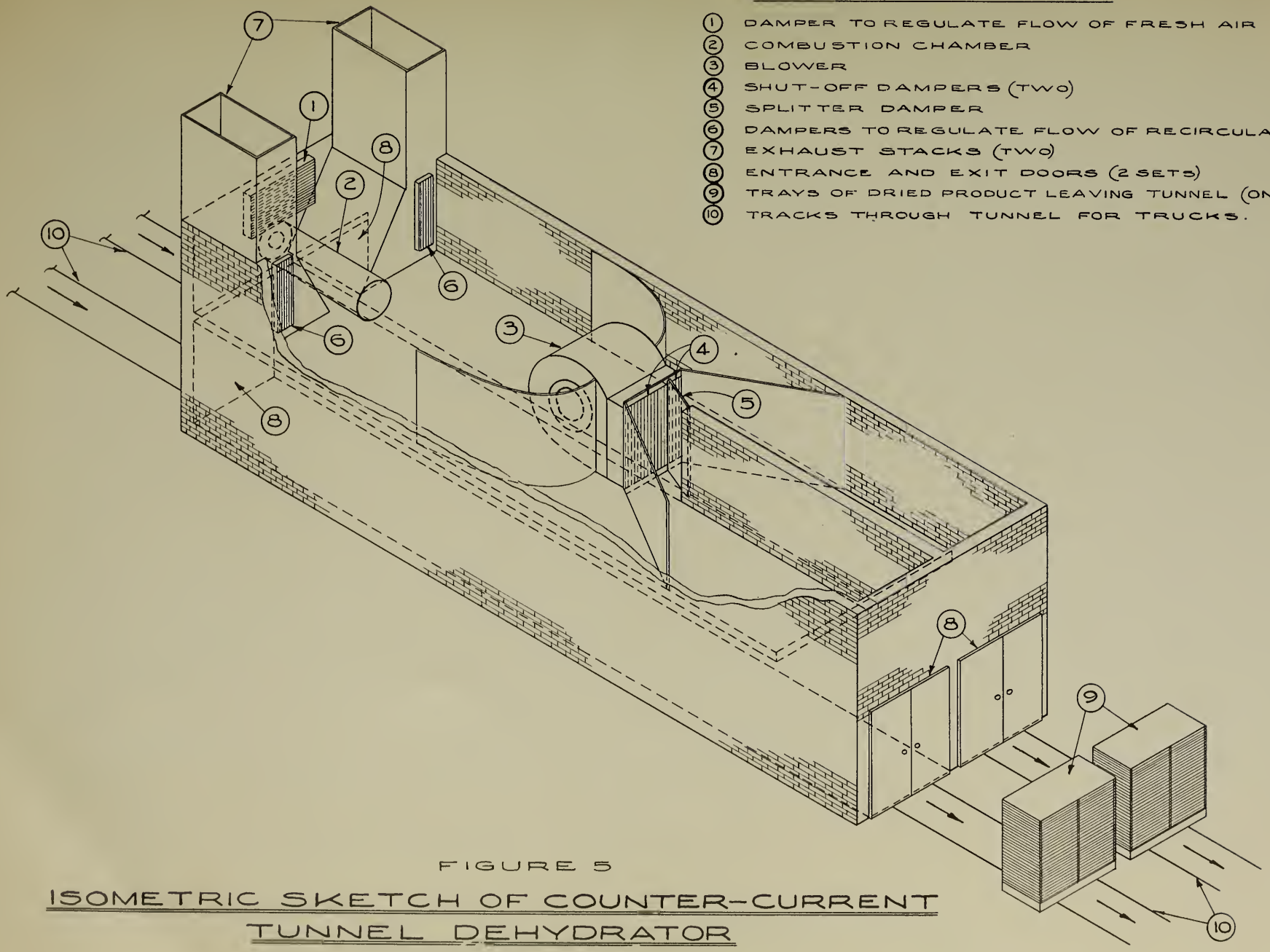
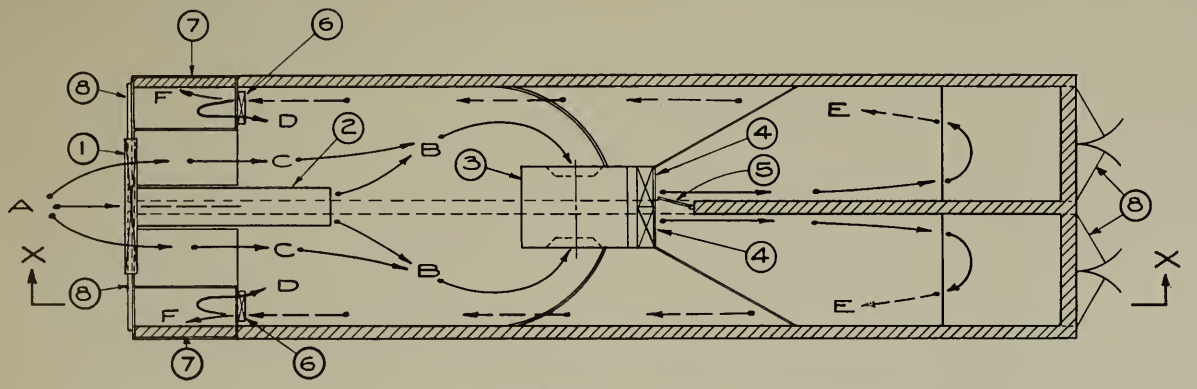


FIGURE 5

ISOMETRIC SKETCH OF COUNTER-CURRENT TUNNEL DEHYDRATOR

(CODE 241)

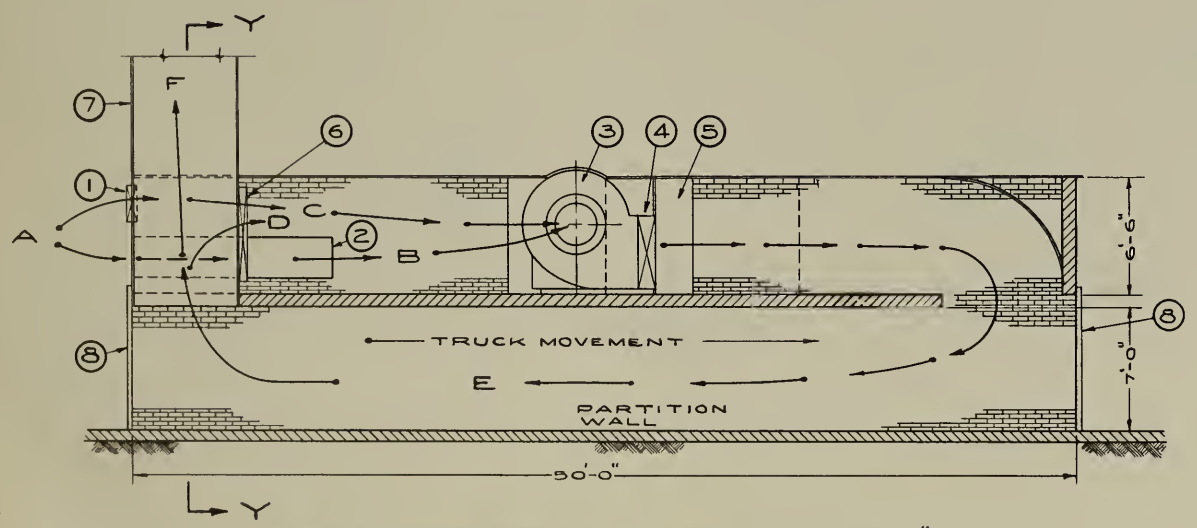


GENERAL NOTES

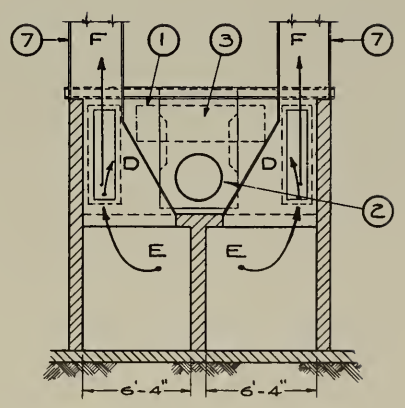
1. DAMPER TO REGULATE FLOW OF FRESH AIR
2. COMBUSTION CHAMBER — 7,000,000 BTU/HR.
3. BLOWER - ACCEPTABLE MODEL STURTEVANT SILENTVANE FAN, DESIGN 10, CLASS I, SIZE 105, DWDI, 30 H.P. MOTOR
4. SHUT-OFF DAMPERS (TWO)
5. SPLITTER DAMPER
6. DAMPERS TO REGULATE FLOW OF RECIRCULATING AIR (TWO)
7. EXAUST STACKS (TWO)
8. ENTRANCE AND EXIT DOORS (2 SETS)

AIR FLOW NOTES

A - FRESH MAKE-UP AIR
B - HOT MAKE-UP AIR FROM COMBUSTION CHAMBER
C - FRESH MAKE-UP AIR BY-PASSING COMBUSTION CHAMBER
D - RECIRCULATED AIR FROM TUNNEL EXHAUST
E - CONTROLLED TEMPERATURE DRYING AIR
F - EXHAUST AIR FROM TUNNEL TO OUTSIDE



SIDE ELEVATION - SECTION "XX"



SECTION "YY"

FIGURE 6

COUNTER-CURRENT TUNNEL DEHYDRATOR FOR POTATOES OR CARROTS (DICED)

(CODE 241)

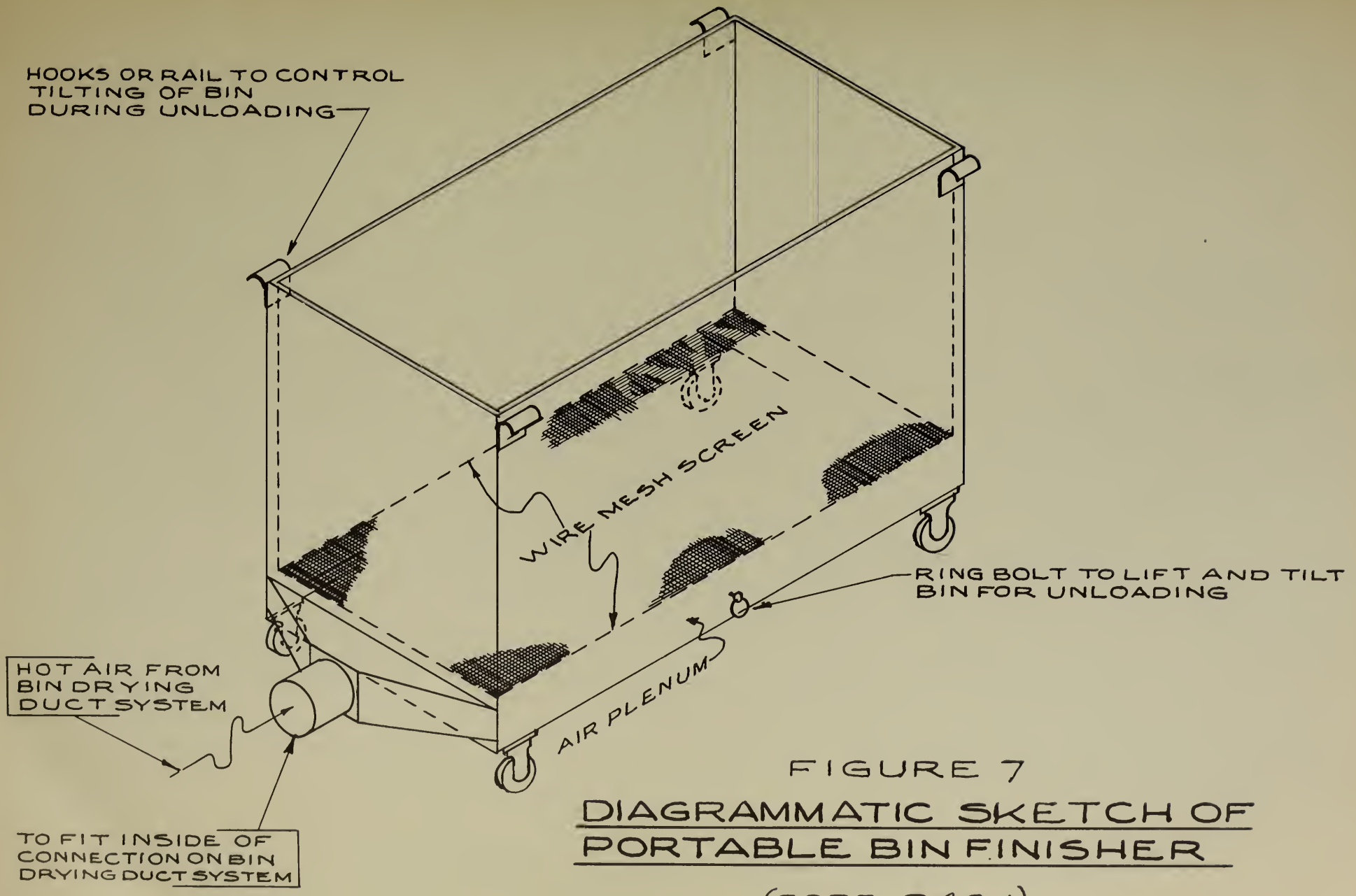


FIGURE 7

DIAGRAMMATIC SKETCH OF PORTABLE BIN FINISHER

(CODE 248.1)

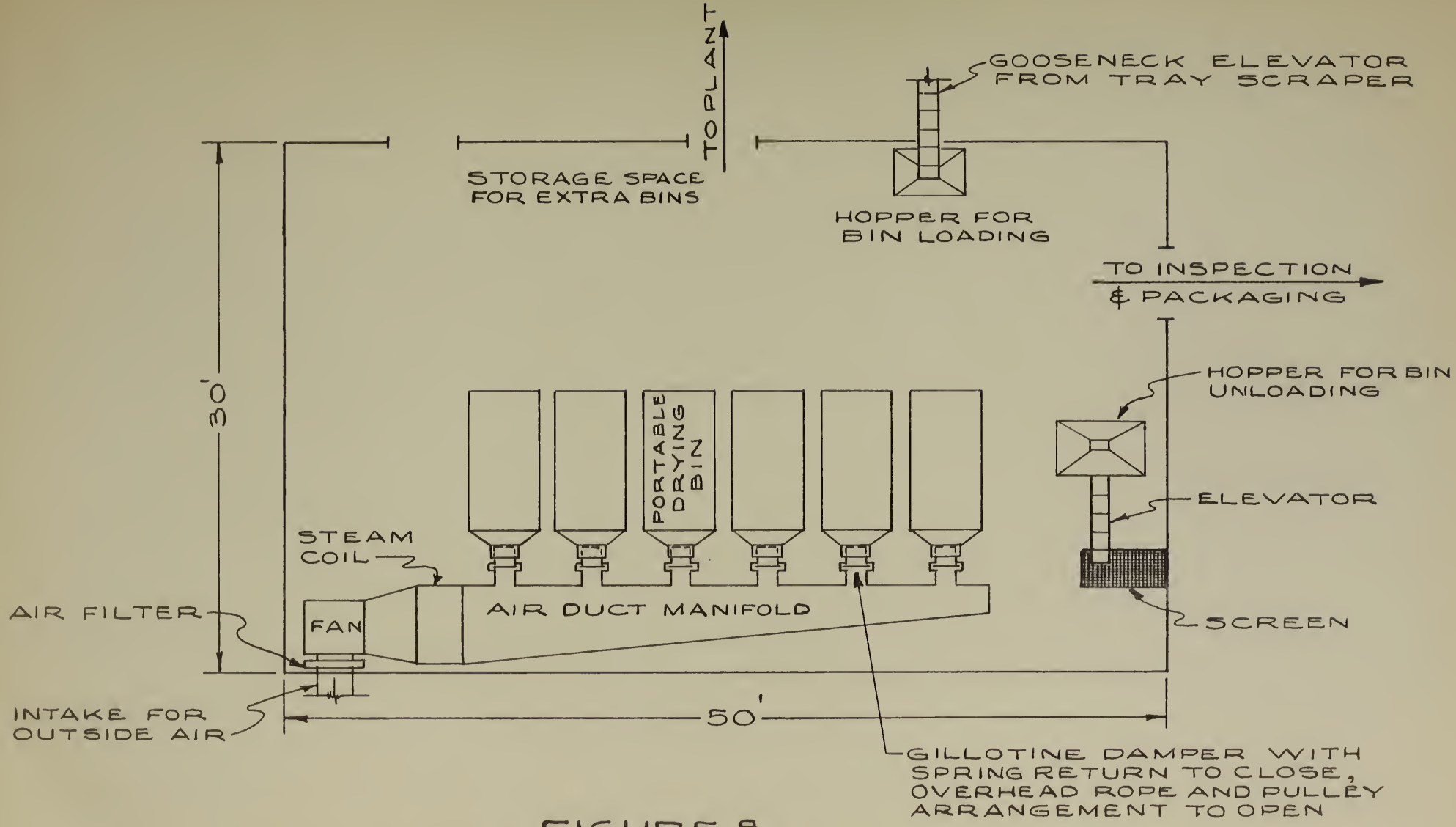


FIGURE 8

LAYOUT OF BIN FINISHING ROOM FOR POTATO & CARROT DICE

CODE 248